THE ENGINEER

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British Railways' Modernisation Plan

LAST Monday, the House of Commons debated the British Transport Commission's annual report. The debate was opened by the Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, Mr. Hugh Molson, who made reference to the railway modernisation programme and to economies in operation which British Railways were endeavouring to make. He said that, last year, economies amounting to £5,000,000 were made and the staff employed on British Railways declined by over 16,000. Within a comparatively short time the British Transport Commission hoped to effect further economies amounting to £15,000,000 a year. The economies under the modernisation plan, Mr. Molson added, would, it was hoped, be additional, as there was the most hopeful scope for tremendous reductions in expenditure as a result of the modernisation plan. Mr. Molson went on to say that he had just heard from the British Transport Commission of its approval of new works at Perth, which included, first, the construction of a new fully-mechanised hump marshalling yard, and, secondly, a new power-operated signalbox. The total cost of those new works was estimated at £1,650,000, but, Mr. Molson commented, the economies would be "of a very remarkable kind." This new marshalling yard, he continued, would take the place of four existing yards which had not been altered since they were originally laid out. They were the cause of delays in traffic, of double handling, expensive inter-yard working, and a general low level of efficiency in the movement of freight in the area. The new signalbox would take the place of thirteen existing boxes, all of which were out of date and in need of replacement.

Standards in Industry

Two "broadsheets" dealing with the subject of standardisation have been published this week by P.E.P. (Political and Economic Planning). The first of them, entitled *Standards in Industry*, indicates the various kinds of standards in use in British industry, and examines the case for—and some of the arguments against—their employment. In addition to British standards, the broadsheet has something to say about foreign and international standards, and claims, in general, that, although "standardisation can bring with it some serious problems, particularly in the short run," the general interest of the community demands the extension of standardisation. The economies of long-run production, it is pointed out, are only possible on highly standardised and simplified products, and such economies are reflected in export prices. P.E.P. emphasises that a regular review of all standards can allow for changing needs, and that, instead of limiting freedom of design or progress in research, the acceptance of standards can contribute to it. The second broadsheet is entitled *The British Standards Institution*. It surveys the organisation and work of the B.S.I., comments on some of its many activities, and suggests that the B.S.I. must do more overseas to publicise British standards and encourage their acceptance. There are also some comments on the Institution's financial arrangements. On this matter, the broadsheet says that "with a widening area of operations and constantly increasing importance in the economy, it is now more than ever necessary to ensure that the finances of the Institution will in future be sufficient to meet its responsibilities to the full, and assured for a sufficient period ahead to allow it to plan with confidence." It is therefore suggested that when the finances of the Institution are next reviewed, it must be considered whether a more solid foundation is desirable, possibly with a quinquennial Government grant and equivalent longer-term subscriptions from industry.

Supersonic Flying

THE Minister of Supply, Mr. Reginald Maudling, made a statement in Parliament on Monday about the control of supersonic flying. He said that investigations carried out under the direction of the Royal Aircraft Establishment confirmed that pressures capable of causing damage could be created by shock waves from aircraft travelling at or above the speed of sound. The extent of the pressure diminished rapidly with the height of the manœuvre and from heights above 30,000ft the effect should not be serious. The Minister went on to explain that manœuvres at supersonic speeds were essential for the development of new kinds of aircraft, for the testing of production aircraft, for the training of pilots, and for realistic exercises, and a complete ban on supersonic flying over these islands could not be accepted. The present measures of control were, however, being revised in the light of the investigations made, so that disturbance and risk of damage could be reduced to the minimum. Mr. Maudling added that the measures in mind for research establishments and contractors would have the effect of diverting most supersonic flying out to sea, though some exceptions to that would always be necessary. It was proposed to issue an instruction to contractors and Ministry of Supply establishments that supersonic flying was not to take place below 30,000ft except in special circumstances where necessary for the development programme, and then only with the Ministry's authority. Similar steps, the Minister stated, were being taken by the Service departments and by Commonwealth and Allied Air Forces serving in the United Kingdom, although the needs of the training programme might limit to a greater degree the extent to which supersonic flight by the Services could be similarly restricted.

World Power Conference

AT the recent annual general meeting of the British National Committee of the World Power Conference, Sir John Hacking was re-elected vice-chairman, and Mr. F. G. Brewer, honorary treasurer. It was decided at the meeting to extend invitations to the National Industrial Fuel Efficiency Service and to the Institution of Heating and Ventilating Engineers to be represented on the committee, and both these invitations have since been accepted. An invitation has also been accepted by the United Kingdom Atomic Energy Authority to be represented on the executive of the British National Committee. Last month a meeting of the International Executive Council of the World Power Conference was held in Paris under the chairmanship of Sir Vincent de Ferranti. There were twenty-eight member countries represented at the meeting. The timetable for the fifth World Power Conference, which is to be held in Vienna next year, was discussed, and a list of the papers to be presented has been prepared. The meeting also considered future meetings, and in particular an invitation to hold the sixth World Power Conference in Australia in 1962. The council decided unanimously to accept that invitation. At the meeting, Mexico and the Saar were admitted as members of the World Power Conference, and recognition was accorded to a committee of the World Power Conference which has been set up in Trinidad and Tobago. There are now forty-six member countries of the Conference.

Steel Castings Research

THE British Steel Castings Research Association has just published its second annual report. It surveys the work of the year ended March 31st, during which period, it is stated, the reputation and usefulness of the Association within the steelfounding industry, and amongst kindred organisations at home and abroad, continued to grow. Last year was the first in which the Association was assisted by a grant from the Department of Scientific and Industrial Research. During the year plans were finalised for the erection in Sheffield of new headquarters premises, including a laboratory and an experimental foundry, which, it is expected, will be ready by the spring of next year. At the end of the year there were forty-five steelfounding companies in the Association's membership. The research programme which the Association has in hand includes work on the mechanism of freezing, on moulding materials and foundry processes, on the properties of steel castings, on steelmaking, and on industrial health. The progress made with all these investigations is described in the report. For the most part these researches are being conducted at various universities. Another matter mentioned in the report is the work of the Association's technical advisory committees. These committees, it is stated, provide a direct line of communication between the Association's staff and member-firms, and thus lead to valuable co-operation in dealing with technical issues. In addition, the committees form a convenient channel through which the Association can arrange for practical trials to be undertaken as required in the foundries of its members. The work of the Association is under the general direction of Dr. R. J. Sarjant.

Industrial Development of Annacis Island, British Columbia

NEXT week, the official inauguration of the causeway and bridge, giving road and rail connection between Annacis Island and the mainland of British Columbia, will take place. This ceremony will mark an important stage in the development of the island, which has been acquired by the Grosvenor Estates for development as an industrial estate. About five years ago, the late Duke of Westminster became interested in investing in industrial development in Canada, and Annacis Island was subsequently acquired by the Grosvenor Estates for this purpose. Development of the island was entrusted to John Laing and Sons, Ltd., and work has now reached a stage where an administrative building and a bank have been completed, and two factories, totalling 60,000 square feet, are under construction. The site development work for the first 200 acres of the island is now well under way, the total area ultimately involved being about 1200 acres. Up to the present, about 1,500,000 cubic yards of hydraulic sand fill have been placed, out of the total requirement of 12,000,000 cubic yards (the island is to be raised from 3ft to 14ft in level in various localities) and drains, pumping stations and access roads have been provided for the first stage development of 200 acres. It is pointed out that the provision of an industrial estate, where factories may be based, and the capital charges for land and building thus obviated, is a novel development in this area. Annacis Island is very favourably situated for industrial development, particularly of secondary industries, having good sea, rail and road communication, and there is every promise for the success of this venture of British capital investment.

Factors in the Working of a High-Speed Train Service

By O. S. NOCK, B.Sc., M.I.C.E., M.I.Mech.E.

No. I

In recent years much work has been done towards the scientific testing of locomotives, and the interpretation of test results in terms of haulage capacity in different sets of running conditions. The first practical application of this work in the improvement of express train services was seen in June, 1954, when considerable accelerations of many trains took place in the Western Region of British Railways. In this article the author comments upon the first six months' working of these trains, and touches upon the operational difficulties encountered. These difficulties are liable to occur equally with newer forms of motive power and with steam.

THE restoration of full pre-war standards of speed on many express trains in the Western Region, taking effect from June, 1954, was a welcome sign of railway enterprise. The fact of its having taken nine years from the end of hostilities to restore facilities available in 1939 can be taken as a measure of the difficulties experienced in post-war years, since the recovery period after the first world war was of no more than three years' duration. From time to time THE ENGINEER has had occasion to comment upon the deficiency in railway speed since 1945, but the civil engineering departments alone have had to carry out a measure of reorganisation to cope with track maintenance under present day labour conditions, and there were times, indeed, when it really seemed as if things were getting worse, not better. How the situation on the more important of the Western Region main lines has been pulled round, so that the civil engineer could remove the speed restriction altogether on lengthy stretches, would make a long story in itself; but in this article I am concerned with the locomotive performance and with operating. So far most of the accelerations have been made to trains working on the Paddington-Bristol route; but the "Torbay Express" has been markedly accelerated, and some notes on its running are included in this article. The trains discussed are as follows :—

These trains were all timed in the Locomotive Testing Office at Swindon, and the point-to-point allowances are arranged to give "constant evaporation" working. Naturally, there are pauses in the steaming where speed restrictions exist, such as the severe ones at Bath (for London-Bristol non-stops) and at Reading, for West of England trains taking the Newbury line. There are less severe gaps, for observance of moderate restrictions such as those at Wootton Bassett, from the Badminton line, at Castle Cary, Midgham and Hungerford.

But before coming to consider any details of the working it will be of interest to summarise the overall results from a passenger's point of view. This, after all, is the ultimate criterion by which a train service is judged, however interesting the engineering work that underlies it. The accompanying summary, Table II, covers every journey I have made on the trains listed in Table I, from June 15, to December 15, 1954.

The engine performance analysis works out as follows :—

Engine class	No. of runs	Total minutes gained	Total minutes lost
"King"	7	41	Nil
"Castle"	42	147	14½
"County"	2	2	Nil
Gas turbine	2	9½	Nil

Without any further explanation, it is obvious that the locomotives themselves are easily master of the new schedules. The "Castle" record would be still more impressive were it possible to omit a run on the 6.1 p.m. run up from Chippenham on which 8 min had to be booked against the engine, not through lack of capacity but—so far as can be judged—due to the temperament of the driver. The normal load of this train during the summer months was 235 tons tare from Bristol to Paddington, with the addition of a slip coach to be detached at Reading. On Friday nights the load was increased considerably, and this particular driver expressed the view to me that the train should have been double-headed, even though the standard of performance required with the increased load was no more than that regularly required on the 9.19 a.m. up from Bath.] Such an attitude has, in my experience, been unique since the accelerations. The vast majority of enginemen have entered fully into the spirit of the improvement of service, and one has only to look at the remarkable record of the 9.19 a.m. from Bath to see the force of this contention.

The detailed record of the working of this train is worth examining, as set out in Table III: a different engine crew was concerned in each one of the twelve runs.

The general standard of running with this train, with loads up to about 450 tons gross behind the tender, is to make an average speed of 70 m.p.h. over the 75½ miles from Chippenham to Slough. This section of line is, in the aggregate, dead level, as the 1½ miles rising at 1 in 100 between Dauntsey and Wootton Bassett are balanced by the gradual fall east of Swindon. Reverting, however, to instances of "Castle" class engines losing on booked time, there were three cases on the very sharply timed 7.50 p.m. from Paddington, all regained on the next stage of the journey, and one on the 1.15 p.m. from Paddington (booked average 66·5 m.p.h. to Bath) on which the combination of two coaches over the normal, plus a heavy south-west gale, caused a loss of 3½ min.

While the record of the locomotives and

TABLE I

Time, departure	Route	Mileage	Booked average speed, m.p.h.	Usual type of engine	Load (usual), tons tare
8.45 a.m.	Paddington-Bristol	118·4	67·6	"King"	235
11.15 a.m.	Paddington-Bath	106·9	60·5	"Castle"	350*
12 noon	Paddington-Exeter	173·5	59·4	"Castle"	345*
1.15 p.m.	Paddington-Bath	106·9	66·5	"Castle"	235
5.5 p.m.	Paddington-Bath	106·9	58·8	"Castle"	380
7.50 p.m.	Paddington-Reading	36·0	62·6	"Castle"	250
8.27 p.m.	Reading-Chippenham...	58·0	61·7	"Castle"	250
8.26 a.m.	Chippenham-Paddington	94·0	60·0	"Castle"	385†
9.19 a.m.	Bath-Paddington	106·9	58·8	"Castle"	380
12.40 p.m.	Exeter-Paddington	173·5	59·4	"Castle"	345*
4.30 p.m.	Bristol-Paddington	117·6	67·2	"King"	235
6.1 p.m.	Chippenham-Paddington	94·0	62·7	"Castle"	270‡

* Summer service loads.
† Load reduced to 350 tons by slip coach at Didcot.
‡ Summer service only. Load reduced to 235 tons by slip coach at Reading.

TABLE II—*Performance Record on Accelerated Trains*

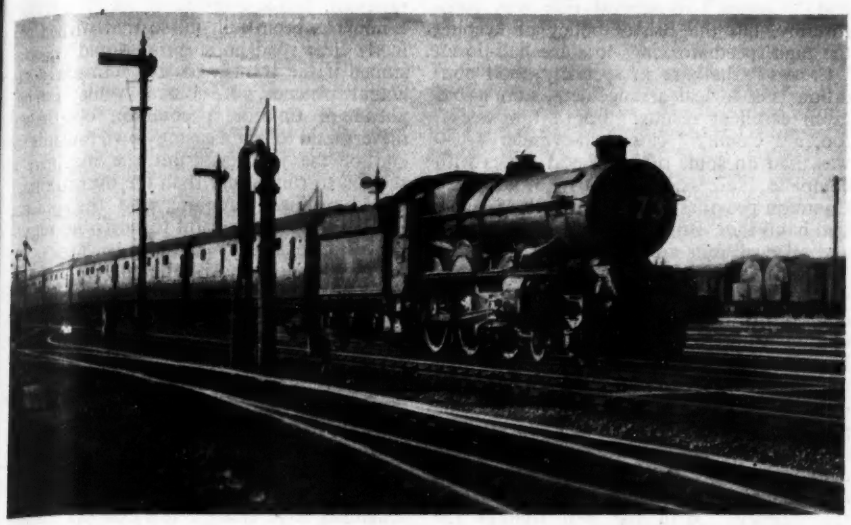
Down trains

Time ex Paddington	No. of runs	Average load, tons tare behind tender	Engine class	Checks, minutes lost average per run		Engine		Arrival		
				Signals	Permanent way	Total time lost, min	Total time gained, min	Number of runs		
								R.T. or early	Up to 5 min. late	More than 5 min. late
8.45 a.m.	1	235	"King"	1½	3½	Nil	5	1	—	—
11.15 a.m.	1	395	"Castle"	—	4	Nil	1	—	1	—
1.15 p.m.	2	268	"Castle"	1½	2½	3½*	1½	1	—	1
5.5 p.m.	8	370	"Castle"	1½†	1½	Nil	16½	2	4	2†
7.50 p.m.	7	250	"Castle"	2½	Nil	2½	1	2	4	1
	1	255	"County"	18	—	Nil	½	—	—	1‡
8.27 p.m. ex Reading	7	250	"Castle"	2½	1½	Nil	34	6	—	1
	1	255	"County"	1	—	Nil	1½	—	—	1‡

Up trains

8.26 a.m. ex Chippenham	2	400/350	Gas turbine	6½	4	Nil	9½	1	—	1
	2	405/370	"Castle"	8½	5½	Nil	6	—	1	1
9.19 a.m. ex Bath	12	385	"Castle"	6½	3	Nil	77	7	—	5
12.40 p.m. ex Exeter	1	385	"Castle"	16	—	Nil	8	—	—	1
4.30 p.m. ex Bristol	6	235	"King"	3½	1	Nil	36	4	2	—
6.1 p.m. ex Chippenham	1	270/235	"Castle"	4	3	—	1½	—	—	1
	1	385/320	"Castle"	3½	2½	8	—	—	—	1

* Gale of wind.
† Two runs delayed by exceptional causes: not included in average amounts of signal and permanent way checks.
‡ Very foggy night.



The up "Bristolian" passing Reading West Junction at 80 m.p.h. Engine 6015 "King Richard III"

their crews can be considered as very satisfactory, the overall record is not so favourable. Out of fifty-three trains observed only twenty-four arrived punctually, while seventeen were more than 5 min late. The causes

TABLE III—9.19 *a.m. Express: Bath to Paddington Performance of "Castle" Class Locomotives*

Load: tons gross behind tender	Actual overall time, minutes	Net time, minutes	Net average speed, m.p.h.	Remarks
405	105½	100	64·2	—
400	119	102	62·8	Signal delays
435	118	100	64·2	Permanent way delays
410	105¼	101	63·5	—
405	105¼	101½	63·2	—
405	109	107	59·9	—
410	108	102	62·8	—
440	105	101	63·5	—
410	121	104	61·6	Relief train ahead
475	124	106	60·5	Relief train ahead
370	119	105	61·0	Fog
365	104½	102	62·8	—

of delay on these latter runs are analysed in Table IV.

The two cases in which engine failures on other trains proved a source of delay both occurred on trains of lesser importance, requiring no more than a moderate output of power; but they were both on through engine workings between London and Plymouth. While care is naturally taken to provide the accelerated trains with engines in good condition, the exigencies of present-day working do not always permit this to be done with the lesser lights. Furthermore, the altogether exceptional demands made upon the Motive Power Department at summer week-ends sometimes has its aftermath at mid-week, when an inadequately serviced engine may, through an oversight, be put on a long working. Something of this kind may have caused the failure of a "Castle" on an up West of England express that led to considerable delay with the up Torbay Express (run 15 in Table IV). The second case of engine failure concerned one of the "Britannia" class "4–6–2's" on the 4.15 p.m. from Paddington. Due to a partial collapse of the brick arch steaming deteriorated until the train was stalled by the brakes leaking on—these engines not having the vacuum crosshead pump standard on former Great Western locomotives. In consequence, the succeeding train, the 5.5 p.m. from Paddington, was 33 min late at Bath.

Engineering work on the line is a factor that is taken into account in the planning of the fast schedules, and save in exceptional cases the locomotives have shown a comfortable margin of power for recovery of any time lost in this way. The most severe handicap in this respect came on run No. 11 (Table IV) when two normal relaying jobs coincided with a minor subsidence, and the effect of the three checks in aggregate was to put the train 10 min behind time. Despite one coach over the normal load the locomotive work was very fine, and almost the entire loss would have been made up, but for signal delays east of Reading. Traffic congestion in one form or another does, indeed, form the major source of delay. It is perhaps inevitable that a closely dovetailed timetable will be sensitive to the insertion of an extra train, and runs 12 and 13 in Table IV show the results from the working of a relief express ahead of the 9 a.m. up from Bristol. Normally, the headway between this latter train and the preceding one—the 8 a.m. from Cardiff—shortens from 13½ min on passing Swindon to 5 min at Southall, and although the Bristol train has 4 min recovery time in the last 9 miles the insertion of an additional train appears liable to cause delay. On No. 13 run checks began at Reading.

The analysis of delays to fast trains such as these discussed in this article suggests that the main cause of trouble is not the fast trains themselves, through engine difficulties, poor coal, and so on, but the operation of other traffic. The 7.45 a.m. express from Bristol to Paddington could not be claimed as a good timekeeper, but, then, the state of the line east of Reading must be borne in mind. It is due in Paddington at 10 a.m. and it is preceded by expresses due at 9.28 a.m., 9.34 a.m., 9.40 a.m., 9.46 a.m. and 9.55 a.m., all using the same pair of metals, and when traffic from Bristol is heavy the 7.45 a.m. itself is preceded by a relief train. All the earlier arrivals in Paddington are fast business trains carrying a regular clientele from dormitory towns such as Reading, Henley-on-Thames, Maidenhead, Bourne End and Slough, and obviously they could not be sidetracked to give priority to a fast long-distance express. Very careful regulation of the working of the entire group is needed, as regards locomotive performance, station times and signalling.

Complaints are often heard in these days of poor operation of freight trains, on sections where there are only two running lines. Slow-moving trains are allowed to proceed from one loop to the next with insufficient margin of time in front of important express passenger trains. With manual block working, however, and the rather cumbersome means of communication between signal-boxes, it is often difficult for a signalman in a "key" box to ascertain just where an oncoming express actually is. Train "intelligence" is far from perfect, and never up to the minute, and one hears of experienced and conscientious men being taken by surprise by the speed of approach of a fast express. With increased experience of high-speed working the incidence of signal checks from misjudgments of this kind have lessened, though, like the heavy occupation of the line ahead of the 7.45 a.m. up Bristol express, they tend to emphasise the need for giving signalmen a clear picture of the state of the line in the approaches to their areas.

The experience of the fifty-three runs under discussion reveals the fact that with one exception the causes of appreciable delay were unconnected with the motive power used on the trains themselves, and would have occurred irrespective of whether steam, diesel-electric, or gas turbine locomotives were in use. At this present time there is much talk of interim motive power pending full electrification, and if the procedure adopted in America were to be followed here one might see diesel-electrics, or other non-steam power taking over the cream of the traffic for a time, while existing steam locomotives would be demoted. In such an interim period the thus relegated motive

TABLE IV—*Delays*

Down	Train	Engine class	Load, tons tare	Delays: Signals	Delays: Permanent way	Exceptional causes	Arrival, minutes late
1	1.15 p.m.	"Castle"	297	3½	2½	3½ min, gale	10
2	5. 5 p.m.	"Castle"	380	—	5	Derailment delays	14
3	5. 5 p.m.	"Castle"	380	—	9½	Engine failure ahead	33
4	7.50 p.m.	"Castle"	250	8½	—	—	8½
5	7.50 p.m.	"County"	255	—	—	Fog delay: Reading	17½
6	8.27 p.m.	"Castle"	250	8	4	—	9
7	8.27 p.m.	"County"	255	1	—	Late start	16
Up							
8	8.26 a.m.	Gas turbine	400/350	12½	4	—	11½
9	8.26 a.m.	"Castle"	420/385	13	4	4 min, late start	20
10	9.19 a.m.	"Castle"	380	13	4	—	10
11	9.19 a.m.	"Castle"	406	8	10	—	9
12	9.19 a.m.	"Castle"	380	13	4	Additional traffic	12
13	9.19 a.m.	"Castle"	440	18	—	Additional traffic	15
14	9.19 a.m.	"Castle"	346	—	—	Fog	10
15	12.40 p.m.	"Castle"	387	2	—	Engine failure ahead	8
16	6. 1 p.m.	"Castle"	270/235	4	3	—	5½
17	6. 1 p.m.	"Castle"	385/320	3½	2½	8 engine and crew	14

These delays can be broadly divided as follows:—

Due to weather	4
Engine failures on other trains	2
Mishap on another line	1
Exceptional traffic (runs 12 and 13)	2
Locomotive (and crew)	1
Exceptional permanent way work, plus signals	1
Signal delays	6

power tends to become "nobody's baby," with consequent deterioration in maintenance and operating efficiency. But, as the operating results with the accelerated Western Region services show, it is, more than anything else, the working of second and third-line duties that governs the punctuality of the crack trains. More than this, in America the booked speeds and loading of the principal express passenger services were taxing steam power to its utmost. Locomotives were habitually flogged to an extent never seen in regular working here, and maintenance costs were heavy. In this country, on the other hand, steam locomotive efficiency is at its highest in the running of first-class express passenger trains, and it would seem that the greatest field for interim "dieselisation" lies in suburban and semi-suburban workings, where multiple-unit trains could be employed. These would need only one engineman and would thus do something to relieve the acute shortage of staff in the motive power departments that exists in many areas.

This discussion, *in extenso*, of the extraneous causes affecting the working of high-speed trains might tend to give the impression that the chief mechanical and electrical engineer, and the motive power superintendent had few problems to contend with; but one can say at once that it is the magnificent spade work put in during the past years on the stationary testing plant at Swindon, in dynamometer car tests, and in the wholehearted co-operation of running inspectors that has made the working of these high-speed trains look relatively easy from the locomotive running point of view. The improved draughting arrangements applied to the "King" and "Castle" class locomotives have proved as successful in service as was anticipated from the Swindon tests; but it is not enough to have a master tool for the job. The psychology of the footplate has to be taken into account. The trains included in Table I are run mostly by the top links at Old Oak Common shed and Bristol, and there are more than twenty pairs of enginemen in each of these links. A different link of Old Oak men have the 7.45 a.m. up from Bristol to Paddington, while Newton Abbot men run the Torbay express. One need hardly emphasise the differences in temperament encountered in large "links" of this kind, and while their seniority in both years and railway service is a guarantee of first-class enginemanship, something more is needed in the running of trains making speeds of 75 to 85 m.p.h. for hours on end.

At both Old Oak Common and Bristol special care has been taken in the allocation of engines to the accelerated trains. One is aware that a sustained attempt is being made on British Railways to systematise locomotive maintenance so that any engine of a class may be put on to a duty rostered for that class, and at sheds like Old Oak Common and Bristol, that have a wide diversity of duties to operate, "Castle" class engines in particular are used as general service passenger machines. From Bristol, for example, they work on secondary duties to Swindon, to Salisbury, and into South Wales, in addition to the crack turns to London, Newton Abbot and Shrewsbury. A high mileage engine might be in sufficiently good "nick" at the front end and steaming well; but the riding is a factor that must be taken into consideration in high-speed workings. I have known engines that were, to use an engineman's expression, "perfect ladies" up to 75 m.p.h., but which got distinctly rough when speed rose high into the "eighties." The Western Region "Kings" and "Castles" in general ride very comfortably, but the Bristol policy of keeping the high speed workings to some half-dozen "Castles" that are in specially good condition is a logical arrangement, and it has given excellent results. For a few weeks, too, a "County" class two-cylinder 4–6–0 was used on some of the fastest duties with complete success. Similarly, Old Oak Common provides the "King" class engine that hauls the "Bristolian" in each direction, and selected units are set aside for this duty.

When the new schedules were being planned very careful attention was given to the question of inserting recovery time as a margin against permanent way repair checks. From the locomotive capacity viewpoint a timing like that of the "Bristolian" may include a margin for recovery; but if the point-to-point times call for a uniform effort throughout there is not, with certain drivers, a definite incentive to run harder when there are engineering slacks to be made later in the journey. With the new timings the policy has been adopted of inserting a definite recovery margin at roughly 50-mile intervals. In the schedule of the "Bristolian" 8 min has been built in, so that with a perfectly clear road no surprise would be occasioned if the train arrived 8 min early. In actual practice, of course, while running ahead of time is a common occurrence, drivers tend to begin easing down towards the end of the journey. But the incentive is there: to run harder than the overall timing would ordinarily require, and the practice has been most successful towards the regaining of time lost by extraneous causes. In my own experience with the up "Bristolian" the gain to engine has averaged 6 min per trip. The working timetables of the Western Region now include a definite statement on the subject of making up lost time, as follows: "When trains are running late every endeavour must be made to recover time subject to the strict observance of all speed restrictions, both permanent and temporary." The locomotive testing office at Swindon in their planning of the accelerated schedules have assisted towards the making of this desideratum of time recovery into practical reality.

(To be concluded)

Association Technique Maritime et Aeronautique

THE 1955 meeting of the Association Technique Maritime et Aeronautique was held at the Maison de la Chimie, 28, rue St. Dominique, Paris. This meeting, which was the fifty-fourth of the Association, began on the afternoon of Monday, May 23rd, with the general meeting and the reading of two papers. Further papers were read at morning and afternoon sessions on Tuesday, Wednesday and Thursday and the meeting closed with a visit to the Centre d'Essais des Moteurs et des Hélices de Saclay.

The proceedings were opened by the President, Monsieur Georges Bourges, who gave the traditional review of the new developments which had taken place in both naval and merchant shipbuilding and in aircraft construction during 1954. He commented that in 1955 several small craft would join the French fleet and that the trials would be held of the first cruiser and first submarines constructed since the war. Aircraft carriers were indispensable units of the fleet and the president stated that construction of the hull of the "Clemenceau" had started at Brest and that work had begun on the propulsion machinery of 126,000 s.h.p., and that the keel of a sister ship would be laid down during the year. While dealing with the subject of aircraft carriers he referred to the 60,000-ton "Forrestal" of the United States, the completion of "Ark Royal" in Great Britain and the modernisation of "Karel Dorman" by the Dutch. Progress made towards the completion of the cruisers "De Grasse" and "Colbert" was referred to and the president noted that work had begun again on three cruisers of the "Superb" class in England and that Russia had in service thirty cruisers of recent construction, while in the United States, experiments had gone forward with guided missiles for anti-aircraft defence.

Monsieur Bourges briefly mentioned the small craft construction programmes of a number of countries and recalled the launch of the submarine "Narval" and said that three of this class would be put into the water this year. The question of atomic energy for propulsion purposes was also mentioned. Turning to merchant ships, the president referred to the ratification of the Convention for Safety of Life at Sea, the conference on sea pollution, the amendment to the tonnage allowances for machinery spaces, and to the seventh International Conference of Tank Superintendents. He remarked upon the work related to skin friction, scale effect and other problems under investigation, the new tank to be built at Feltham, and went on to discuss hull strength experiments and the beam theory. Other matters referred to were: questions of stress concentrations at the corners of openings; steels for welding; developments in aluminium alloy construction; cathodic corrosion protection; and plastics for small boats. The machinery developments included the advance in the pressure and temperature of steam for turbine machinery, the supercharging of diesel engines and the plan to install a gas turbine in an oil tanker.

With reference to developments in aircraft, Monsieur Bourges mentioned various speed and altitude achievements and progress in the production of smaller aircraft in a number of countries and then turned to activities in France, where the "Mystère IV B" had exceeded the speed of sound in level flight.

"Atomic Energy and Propulsion of Vessels" was the title of the first paper on Monday afternoon; it was read by Monsieur Salesse. The author reviewed the principles of atomic energy and examined some of the atomic reactors and then went on to discuss the reasons for the slow development together with present and future possibilities. Attention was drawn to the fact that, despite the enormous specific energy of atomic fuel and its apparent cheapness, very few atomic reactors have been or are being constructed as propelling power units for ships. P. Sarte presented the second paper which was entitled "The Cargo and Passenger Liner" and which discussed the problems of this class of vessel, including construction, subdivision, powering, cargo handling gear, and operating expenses. Outline arrangements of three groups of such ships were given and a tabular statement compared cargo-passenger with cargo ships in each group.

At 9 a.m. on Tuesday morning, the meeting was continued with a paper entitled "The Problems of Sea and Air Radio-Navigation" by F. A. Bouteiller. In this paper the methods of resolving the problems of sea and air radio navigation were examined and note was taken of developments especially with regard to the air. Several systems in use were discussed and among them were "Loran," "Decca" and "Consul," each of which was accompanied by a map showing the coverage given by the system concerned. The second paper of the morning was "Electronic Equipment of the Air France Long Distance

Super Constellation," by J. Ducasse, in which the author reviewed the inquiries made before selecting the electronic equipment of the Air France Super Constellations. He then went on to give brief particulars of the various items of the installation concerned with radio navigation, approach and landing, semi-automatic and automatic piloting, and the receiving and transmitting distribution to the crew spaces.

The next paper, "Radar for Merchant Ships," by E. Giboin, dealt with the merchant marine radar specifications of a number of countries and examined the question of the training of merchant navy officers and pilots in the use of radar. However, warning was given that despite the value of radar, it had certain limitations of which it was essential to be aware. In his paper "The Short Range Radio-electric Locating Processes," P. Hugon set the problem of accurately determining the position of a ship at a distance of about 50 miles from the shore by means of radio-electric systems and then examined the applications of such systems to the problem, including those concerned with

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direction, distance, azimuth-distance and the hyperbolic systems which included "Rana," "Raydist" and "Decca."

At the afternoon session six papers were read and discussed, the first being "A New Method of Measuring Propeller Pitch," by G. Ganson, who mentioned three methods of measuring the pitch of a propeller and described how the addition of an optical level to a conventional device had produced a portable and accurate pitch measuring instrument. The next paper was presented by H. de Goriainoff, and entitled "River Trials of Self-Propelled Inland Navigation Boats." The series of self-propelled boats were built to dimensions imposed by the size of the locks, which have a length of 127ft. Four classes of barges with different block coefficients were built and a diagram reproduced the lines plans of the various craft. Speed and power were shown, plotted for various degrees of loading, and tables gave the particulars of the river craft built during the reconstruction programme carried out during the years 1948–1955, and the results of the trials of the latest series of barges of restricted length.

"The Optimum Propeller Diameter" was the title of the third paper of the afternoon. It was given by Professor L. C. Burrill, who re-examined the problem of the optimum diameter of a marine propeller by means of the vortex-momentum blade element theory and studied the optimum pitch variation in a variable wake. Graphs gave the results obtained in a cavitation tunnel and curves of optimum local efficiency. R. Guilloton gave the next paper which was entitled "The Induced Camber of Thin Wings" and which aimed to extend to aerofoils the classical vortices diagram for the investigation of lift lines. The terms and definitions of the problem were stated and the investigation included a mathematical method of estimating incidences and induced cambers together with a table of the functions required in the calculation. The properties of thin sections were generally discussed as was the problem of the construction of a wing to give pre-established characteristics together with the analysis of the experimental results obtained with an existing wing. The same author gave the next paper, which was "Application of Induced Camber to the Calculation of Ship Propellers" and was concerned with introducing the terms of induced camber, established in the previous paper, into the propeller theory developed by the author. The paper established the main terms of the propeller theory and then presented detailed calculations for a given propeller together with remarks upon the cavitation problem. "Survey at Sea of Ship Resistance and Propulsion and Model Correlation," presented by R. Retali and S. Bindel, concluded the reading of papers on Tuesday. The trials consisted of the towing of a minesweeper by an identical minesweeper, the boats concerned being the "Aldébaran" and "Sirius," and details were given of the towing and resistance measuring arrangements. Trial results were recorded in tabular form and curves showed the comparison of ship with model based upon Froude formula and Schoenherr line.

The meeting was continued at 9 a.m. on Wednesday, May 25th, with the reading of "Some Applications of the Lining-up Projection Apparatus," by J. Legris, a paper which referred to an earlier paper given in 1950 and was concerned with three special applications. Descriptions were given of the method of checking that a series of bored apertures are in a straight line; the determination of the displacement and slope at any point of an assembled line of shafting; and of the use of the instrument as an optical gauge. J. Brocard presented the next paper, "Some Considerations of Residual Stresses," and observed that partial heating of a fabricated metal unit sets up internal residual stresses when the yield point was passed at any point. The process of the setting up of residual stresses was illustrated together with the methods of measuring them and of their relief, wholly or in part. A graph showed curves of constant temperature plotted to a base of residual stress and time followed by a note upon controlled low temperature stress relief. H. de Leiris contributed a paper entitled "Remarks Upon Oxygen Cut Edges," which investigated the effect of cutting by oxygen using a guided blow pipe upon the properties of steel, near the cut, such as crystalline structure, hardness, and residual stress distribution. Four qualities of steel, generally used for plates for ship construction, were examined. Hardness figures were shown graphically and there were photographs showing the macro and micro structure of each of the steels in the vicinity of the cut edge. In the third paper read during the morning and entitled "The Flexibility of Shafts and Its Effect Upon the General Curvature, Bearing Loads and Bending Stresses," the author, J. Legris, stated that the line of bearing points of a line of shafting in a ship is considered to be rectilinear at the time of construction and that various methods of sighting all assist towards achieving great accuracy. It was considered that the assembly criteria and location of bearing points would cause the final alignment to be far from straight and drawings gave the out-of-alignment figures for two cargo ships and two oil tankers. The paper demonstrated different alignments of shafting and how to investigate the influence of the location of bearings. The next paper, "Contribution to the Technique of Remetalling Metallic Surfaces by a Metallizing Spray Gun," by A. Vastel, set forth the principle of jet metallisation and the field of application and described the methods of preparing material, of spraying and machining. Data necessary for the planning and establishment of a metallisation department were put forward and tests required for the standardisation of spray metals were enumerated.

Six papers were read during the afternoon, beginning with "Comparative Survey of the Power of Merchant Ship Machinery," by G. Deparis, in which the author referred to a formula, quoted in his 1953 paper, which gave a coefficient representative of the relationship between horsepower and deadweight. The paper contained tables of coefficients for a large number of ships of varying deadweight and speed, by use of which it is considered possible to estimate optimum dimensions and power for a cargo ship of a given deadweight and speed. In the paper that followed, "Shipbuilding and the Pollution of the Sea," by Y. Rocquemont, the author gave a brief historical review of the matter together with the main provisions of the 1954 International Convention. The effect of the new regulations upon the building and operating of ships was analysed and the methods for avoiding pollution reviewed. Professor H. E. Jaeger presented his paper, "Complementary Analysis of Stress Measurements in Transverse Bulkheads Built of Vertical Corrugated Plates," which was complementary to his paper read in 1954 and gave the results of strain gauge tests. Graphs showed the measured results plotted against the calculated figures and it was considered that the results confirmed the method of calculation. In the fourth paper entitled "Possible Errors between Air and Sea Signals," the author, A. de Rouville, set forth the conditions under which lighthouses and wireless beacons, intended primarily as an aid to seamen, could help air navigation and then stated the precautions necessary to ensure correct identification of a light. He mentioned the steps taken by international conferences to remove uncertainties and the means provided to assist the navigator in correct recognition. "Towards an International Tonnage Measurement," read by Y. Rocquement, was the title of the next paper which gave a critical analysis of the tonnage laws and of the modifications already adopted or contemplated. Their influence on ship construction was considered and to overcome the complication of the various tonnage measurements the author recommended the suppression of net tonnage and the adoption of a method of measurement based on displacement or deadweight. The final paper read on Wednesday, was entitled, "The Erection of a Perforated Windscreen Wall for Berthed Ships," and consisted of two parts. Part I was by J. Valenci, had the sub-title "General Considerations and Aerodynamic Investigations" and gave an

estimate of the strains on a berthed ship, due to gusts of wind, together with the means suggested to give protection. The protective effect of the proposed windscreen wall was investigated in a wind tunnel and the results included in the paper. Other investigations were made on porous strips and an expression established for drag and aerodynamic porosity in terms of geometrical permeability. The second part, with the subtitle, "Description of the Screen Built on the Long Side of Shed 19 in the Port of Marseille" and contributed by A. Flinois, related the building problems caused by existing structures and installations and gave details of windscreen structure.

On Thursday, the first paper presented was "Calculation of Stresses in Stiffened or Unstiffened Ends of Pressure Vessels under Uniformly Normal Pressure," by J. Barthelemy. The paper referred to the principles and practical implications of a general method of computing stresses, as put forward in previous papers, by Monsieurs Salet and Barthelemy, and pointed out that the method presented difficulties when related to thin shells. Modifications to the formula were proposed to allow of general application and the paper included actual calculations. "How Stresses and Deformations are Redistributed in a Reinforced Cylindrical Shell under Uniformaly Normal Pressure" was the title of the paper given by G. Salet, in which the author summarised his general method of calculating stresses and deformations in reinforced cylindrical shells. The manner in which stresses tend toward limit values at successive reinforced panels of the shell was examined and it was shown that the differences between each section decrease as a geometrical progression. In the next paper, "Investigation of Fractures which Appeared in the Stern of a Cargo Ship in Service," H. de Leiris reported that the various forms of fractures which had occurred at the stern of a cargo ship had been ascribed to fatigue stresses. The fractures were compared with those observed on other ships and with laboratory produced fractures and it was concluded that the cause was the assembling technique employed which impaired the stiffness and strength of the stern. As a result of the examination the paper drew attention to points of design which should be avoided in those parts of a ship's structure subjected to cyclic stresses. The fourth paper, "Study of the Resistance to Torsion of some Shaft Couplings," by Monsieur Ballet, investigated the resistance to cyclic torsion of standard key couplings, including various shapes of keyways, and of oil pressure couplings. The results indicated that the latter design of coupling appeared to have greater resistance than keyed couplings. The concluding paper of the morning session was presented by H. de Leiris and H. de Goriainoff and entitled "Systematic Failures Observed at the Aft End of Self Propelled Barges." It was recorded that eleven out of the 600 self propelled barges of 38·8m in length, built since 1948, had developed fractures in the after part after a number of years of service. Investigation into the service conditions and a morphological analysis of the fractures had indicated that the cause was vibration set up by second degree forces generated by certain two and four-cylinder four-stroke engines. The authors suggested possible remedies such as reducing the exciting forces and increasing the resistance of the structure to vibration.

J. Grosmangin opened the afternoon session with his paper "Cellular Materials Based on Polyurethanes," in which he suggested that synthetic cellular materials may be temporarily useful for the solution of stiffening problems as well as having sound and heat insulating properties. Materials based on Polyurethanes were studied at the Office Nationale d'Etudes et de Recherches Aeronautiques and the author endeavoured to demonstrate the advantages they offered by making comparisons with other light synthetic materials. In the next paper, "Alteration of Investigation Methods Regarding Longitudinal Stability of Airplanes," by E. Billion, the author indicated that he wished to change from the variables used in standard investigations and use new ones and vector notations. He gave an example of the application of the method. Ph. Poisson-Quinton and P. Jousserandot in their paper, "Airplane Hyperlift and Piloting by Control of Circulation" examined the control of circulation around a wing profile both theoretically and experimentally and reached adequate agreement in the choice of fundamental parameters. The fourth paper of the afternoon session was "The Turbine Testing Station of the French Navy at Indret," by J. Chevallier and R. Ferry, and gave particulars of the testing station which is equipped for full power testing of geared turbines up to 65,000 h.p. Drawings showed the general arrangement of the station and photographs showed a number of sets of machinery on test. Measurements involved in the determination of specific consumption were discussed and the paper outlined some of the tests carried out while graphs and tabular statements recorded data related to the trials of turbine auxiliaries. The final paper presented at the meeting was "Subsonic Flow in a Helico-Centrifugal Compressor," by E. Maillot and J. Le Manach.

Annual Banquet

On Thursday, May 26th, the Association Technique Maritime et Aéronautique held its Annual Banquet at the Hotel Lutetia, Paris, under the presidency of Monsieur Paul Antier, the Minister of the Merchant Marine. The dinner was attended by a company, numbering nearly 170, which included serving officers of the French Navy and Air Force, representatives of government departments attached to the services, shipbuilders, shipowners, engineers, Naval, Military and Air Attachés of Denmark, Great Britain, Russia, Spain, Sweden, United States and Yugoslavia, and several representatives of the technical press of Great Britain.

At the kind invitation of the Chambre Syndicale de Constructeurs de Navires et de Machines Marine a small group of British technical journalists made the journey to Marseilles to see something of that well-known port and to visit the shipbuilding and engineering works in the vicinity. The first visit was to Les Chantiers de la Seyne sur Mer of the Société des Forges et Chantiers de la Méditerranée, a company which was formed more than 100 years ago while the shipyard has been the scene of shipbuilding since 1835.

Reconstruction has made good the war damage sustained by the plant and the yard, which covers over six acres, has five building slips and a frontage of about one mile including a fitting out quay about 1500ft long and a wet basin measuring 460ft by 230ft, with 30ft depth of water. The building berths vary in size and cater for ships ranging from 360ft to 660ft in length and the company build passenger and cargo ships, but not oil tankers, and notable among post-war construction is the passenger-cargo ship "El-Djezair," which has machinery arranged aft. Cranes serving the berths and quays include a number capable of lifting 40 tons and there is a 150-ton floating crane which, among other purposes, is used to move cranes from track to track between the slips as the need arises. Excellent welding facilities are provided and it was of interest to note that it is yard practice to immediately paint over the welds, while in the plate shop heavy cross girders supported the crane rails to give maximum clear floor space. In the well-equipped engine and boiler shops the company build turbine machinery and Sulzer diesel engines and the F.C.M. boiler which has no brickwork in the combustion chamber, natural circulation, flexibility of output and is able to raise steam quickly. Another well-known product of the company is the "Strombus" funnel which was designed to solve the problem of keeping the decks of a ship clear of smuts and smoke.

Further along the coast toward Marseilles we visited the Chantiers Navals de La Ciotat, which was founded just over 120 years ago. The present establishment is sited, as can be seen from our photograph, on the waterfront in the middle of the town and has two building berths and a dry dock and is connected with the engine shops by a bridge which spans the main road. The berths, one of which is being resited and lengthened so that eventually it will be possible to build 50,000-ton deadweight tankers, have excellent crane coverage and there is also a floating crane of large capacity. Accent is upon welding and prefabrication to reduce building time and the yard has built a 32,000 tons deadweight oil tanker in eight months, and fabricates steel at the rate of 2000 tons per month. The engine works build Foster Wheeler boilers, Nordberg diesel engines and Reavell air compressors under licence and also construct small size tracked tractors.

The third company to be visited was the Chantiers et Ateliers de Provence which has its engine works in Marseilles and its shipyard at Port de Bouc in a sheltered bay at the entrance to the l'Etang de Berre. Each establishment employs about 1300 workers. The works at Marseilles has a capacity of 40,000 h.p. per annum and builds reciprocating steam engines and Prudhom Capus boilers as well as Doxford oil engines up to 9000 b.h.p. under licence. Five Doxford engines are at present under construction, with the boiler shop providing the welded frames, and the works undertake all general repairs to a variety of installations in the port as well as carrying out voyage repairs to many ships using the port. At Port de Bouc it was not until 1950 that the demolitions carried out by the Germans in 1944 were made good, and the shipyard was once again in full operation. Of the original six berths only three are in use, one of which is served by a 30-ton overhead travelling gantry, and reorganisation is going forward with a view to employing the maximum amount of prefabrication in ship construction. The yard, which can build ships up to 12,000 tons deadweight, and specialises in the construction of banana carriers, covers an area of over 90,000 square yards, while the separate fitting yard has an area of 37,000 square yards, two quays served by cranes of 25 tons and 20 tons capacity and a set of shear legs capable of lifting 60 tons.

The return journey to Paris was broken at Lyons to visit the works of the Socié.é Industrielle Générale de Mécanique Appliquée, Venissieux and Villeurbanne. At Venissieux the company has well equipped shops for the manufacture of free piston diesel engines. A small unit of 60 h.p. is built and incorporated in a mobile compressor set which delivers 220 cubic feet per minute at 85 lb per square inch and has a total weight of 4300 lb. The main production line is concerned with the building of the Mark GS 34 gas generator which has pistons of 340mm and 900mm diameter and a stroke of 500mm and develops 1000 h.p. Three to four generators are completed per month but production could be increased to about fifteen per month. There are four test beds where each machine undergoes trials lasting about two weeks. While in the test house we witnessed a dismantling operation which demonstrated that one cylinder could be removed in fifteen minutes and that the space required was one metre. Several engine builders are interested in the free piston diesel engine and a prototype engine is under construction for Smiths Dock, Ltd., while a project is under discussion to install a large number of free piston gasifiers in a ship to form a multi-engine unit of large power. The works at Villeurbanne are engaged on precision work such as disc clutches, diesel engine oil fuel injection pumps and special hydraulic equipment.

Oil Consumption.—Figures published by the Petroleum Information Bureau on behalf of the United Kingdom Petroleum Industry Advisory Committee show that the demand for petroleum products continues to grow in the United Kingdom. The total inland consumption in the first quarter of the present year was 5,802,679 tons (excluding bunkers for ships in the foreign trade), an increase of 5 per cent on the figure for the preceding quarter, and of nearly 14 per cent over consumption in the first quarter of 1954. The increase was primarily accounted for by heavier consumption of gas, diesel and fuel oils, it is stated. In the first three months of the year well over 2,000,000 tons of these products were delivered into the United Kingdom market (additional to quantities used in the oil refineries themselves), and there was an increase of nearly 23 per cent in consumption, as compared with the first quarter of 1954. Although no details are given of production by United Kingdom refineries, it is stated that refinery consumption of oil fuels rose from 452,398 tons in the first quarter of 1954 to 521,441 tons in the first quarter of the present year, and, despite the rising home demand, substantial quantities of surplus petroleum products continued to be available for export.

Installation of a 2000-Ton Forging Press

The installation of additional heavy equipment of large dimensions in an existing shop almost invariably necessitates extensive structural alterations, and the problems involved are often complicated when the headroom required exceeds that normally available. Here we describe the problems involved in the foundation and installation of a new 2000-ton flanging press and its associated equipment at the Renfrew works of Babcock and Wilcox, Ltd.

IN order to provide adequate equipment to meet the manufacturing requirements of large modern pressure vessels and in anticipation of future developments in design, it is necessary to maintain a continuous programme of plant extension and re-equipment at the Renfrew works of Babcock and Wilcox, Ltd. As part of this programme it was decided some time ago to install a new 2000-ton capacity hydraulic flanging press and associated equipment suitable for the production of very heavy boiler drum ends and forgings. With a press of this capacity the firm would be able to process plates up to 12ft 6in square and 7in thick—the largest size available for this class of work—and at the same time supplement the existing productive capacity for smaller forgings.

The installation of such a press would normally have entailed extensive preliminary alterations to the shop structure to provide for the height of the machine and give the necessary headroom for the overhead crane required to serve it. In order to avoid need for these alterations it was decided to install a downstroking press in a pit, with its moving lower crosshead and operating cylinders and rams suspended from a table fixed at floor level. With this arrangement the maximum overall height required for the moving top table with its stroke of 8ft has been kept to under 19ft ; need for structural alterations reduced to a minimum ; and the work involved in installation restricted to a relatively small adjoining area so that normal shop work was able to proceed uninterrupted.

The contract for the construction of the necessary foundations for the press was placed with Balfour, Beatty and Co., Ltd., a 2000-ton press to the particular requirements was ordered from Fielding and Platt, Ltd., and a new furnace to serve the press was ordered from the Dowson and Mason Gas Plant Company, Ltd.

The construction of the foundation for the press entailed the formation of a circular well approximately 40ft deep. This presented an interesting civil engineering problem, as the ground water level at the site lies 15ft below the surface, and under that is encountered a very fine brown sand and silt typical of the south bank of the River Clyde. Excavation through this highly unstable material had to be carried out in such a way that there was no danger of upward movement at the bottom of the excavation. The possibility of such a movement could not be risked in view of the danger of settlement damaging the plant which was situated close beside the foundation well.

It was decided to carry out the work by piling to a suitable depth, then to excavate as far as possible within the piles by conventional means as long as the inflow of water through the bottom of the excavation was not excessive ; then to flood the excavation to natural water level and carry out the remainder of the excavation under water, thus stabilising the bottom ; and then to place a mass concrete plug under water, pump out and complete the concrete lining in the dry. The main stages in the construction of the well can be seen in the diagram Fig. 3 and the photographs we reproduce.

A pile penetration of 70ft was required, and this was achieved by piling in two stages. The first stage was carried out in stable ground and Larssen No. 3 piles, 32ft long, were driven in a circle of 48ft 5½in P.C.D. A 10in by 8in rolled steel joist waling ring with a concrete packing was placed round the top of the piles and excavation was then carried out by 2 cubic yards grab to a depth of 20ft. For handling and driving the piles and for the grabbing work a 10-ton derrick crane with 100ft jib was used.

The second stage of the piling was carried out by driving Larssen No. 4B piles, 50ft long, concentric with the first ring of piles at 41ft 3½in pitch circle diameter. A reinforced concrete waling ring was placed between the rings of piles as illustrated.

With pumping to keep the pit clear of water now flowing in through the bottom, excavation by grab was continued to a depth of 32ft. At that depth this inflow was approximately 200 gallons per minute, and it was not considered advisable to excavate further in the "dry." Concreting of the wall lining was then commenced and the concrete taken a little above the water table, as illustrated in (*a*), Fig. 3. Placing of this concrete at this stage held the piles firmly in place and gave additional weight against upthrust in the latter stage of construction when the pit was dewatered and allowed concreting of the top 13ft of the wall to be completed when work would otherwise have stopped, during a later period when the pit had to remain flooded while the base concrete was maturing. The upthrust, once the bottom plug was placed and the water pumped out, amounted to approximately 660 tons, more than the weight of the concrete plug and this was resisted by the weight of the wall lining mentioned above and the pile friction.

It is of interest to note here that scaffolding for concreting and shuttering the wall was dispensed with by utilising a small raft and allowing the water to flood within the excavation and rise

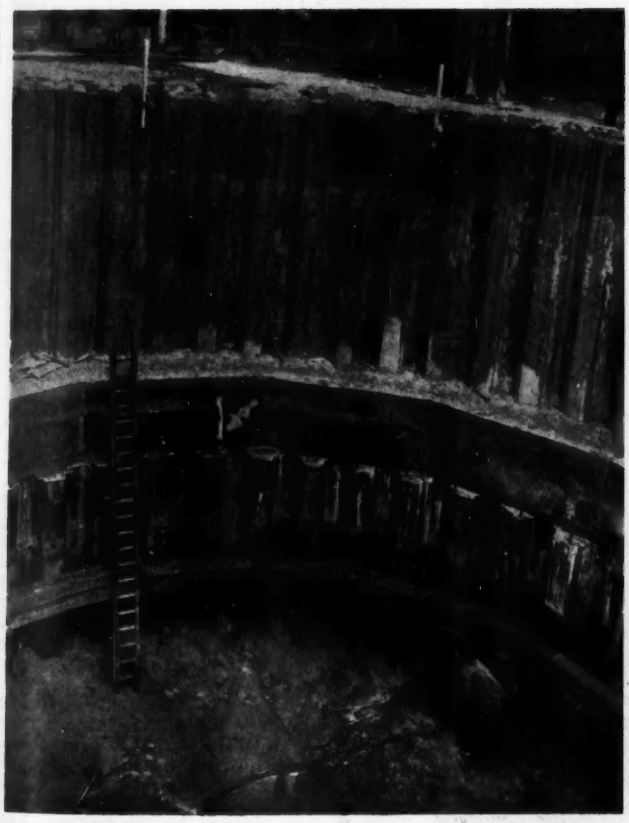


Fig. 1—Pit during excavation before flooding. The waling ring for supporting the piles in the final stages of excavation can be seen near the bottom of the pit

Fig. 2—Supporting steelwork for 2000-ton press. The brackets on the side of the main columns are for the adjustable press-supporting beams

to suitable levels by controlled pumping as concreting progressed.

With the pit flooded to natural water level grabbing continued to the final depth of 52ft 6in. A waling ring which was necessary to support the piles over this final stage can be seen in one of the illustrations (Fig. 1). This ring was fabricated to give a clearance of 6in from the piles. Before concreting of the first wall lift began this ring was placed in a trench as shown at (*a*) Fig. 3. Here it was surrounded with sand and chained to the concrete above so that whilst the subsequent excavation was carried out under water the ring dropped under its own weight and settled down into its required position at a depth of 42ft. In that position it was packed with bagged concrete by a diver before further excavating was done.

After the piles had been scraped clean by the diver to ensure good bond with the concrete the concrete base plug was placed under water. This was poured in batches, each of 3 cubic yards, using a suitable drop-bottom skip, which could be opened and shut as required. This concreting was carried out in the three stages (as at (*b*) Fig. 3). A 1ft layer of concrete containing a plasticising agent was first poured to seal the bottom. Two 4ft deep lifts of concrete containing a waterproofing agent were then poured, each batch being placed in positions predetermined from soundings to give a level surface on completion. This concrete was left for fourteen days to mature with the pit flooded, and during this period the top section of wall above water level was completed. The water was then pumped from the pit and the remaining lower wall section was concreted and floor concrete screeded to final level.

The construction of the foundation took 7½ months to complete and for it truck-mixed concrete supplied by Jaeger System Concrete, Ltd., was used throughout. The following quantities which were involved in the work are of some interest: excavation, 3100 cubic yards; concrete, 1500 cubic yards; reinforcement, 11 tons; weight of concrete plug, 820 tons.

The steelwork erected in the pit to carry the press was supplied by Redpath Brown and Co., Ltd., and it can be seen in Fig. 4. This steelwork supports a load of some 450 tons and itself weighs about 110 tons. It consists of four sectional columns supporting two rigid double-beam members, from which the press is carried by brackets bolted to the fixed table. A heavy panel is fixed in the pit wall opposite each end of the two beams and a deep tapered plate is set between these panels and the beam ends. The tapered plates can be drawn down by bolts to act as wedges, and they provide a means of adjustment for taking up any possible movement on the cross beams which may occur after the press has been placed in service.

A particularly interesting feature of this press layout is the fitting of an anvil moving gear by which the dies and heated plate can be positioned on a slide at one side of the press. This slide carries the work into the press and out again at the end of the forging operation. With this arrangement the fullest use can be made of the overhead crane for all heavy handling and the labour and loss of time normally entailed in manœuvring heavy dies and plates between the columns of the press is almost eliminated.

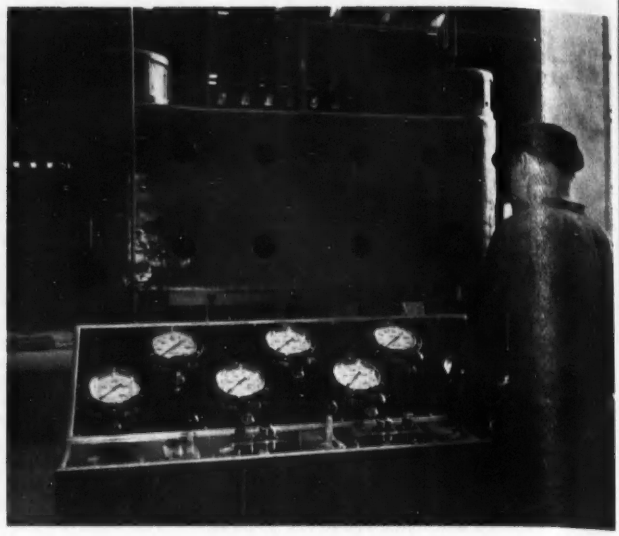


Fig. 5—Control desk with top table of press in the background

The general arrangement of the press and slide installation can be seen in the photograph Fig. 4 and the drawing we reproduce in Fig 6. Power for operating the press is obtained from the works' main hydraulic system, which supplies water at 2240 lb per square inch. The leading particulars of the press are given in the table below.

The massive steel casting which forms the main fixed table of the press incorporates the four supporting brackets of the machine and has bosses at each corner which are lined with cast iron guide bushes for the main columns. The centre of the table is cored to take the ejector equipment, and stops for the bottom moving crosshead are formed on its underside. Its upper or working face is machined to take a fixed slide bolster. The operating rams of the six main hydraulic cylinders and two drawback cylinders attached to the bottom moving crosshead are bolted to machined faces on the underside of the main table.

Power of press :	
Centre rams only	667 tons
Two outside rams	1334 tons
Total power with all rams in operation	2000 tons
Working pressure	1 ton per square inch
Stroke of moving press head	8ft
Maximum daylight of press	11ft 6in
Minimum daylight of press	3ft 6in
Column centres :	
Left to right	14ft 6in
Front to back	10ft 3in
Bolster slide plate dimensions	13ft by 12ft 6in
Approximate overall height of press above floor level	18ft 9in max.
Power of ejector cylinder	400 tons
Stroke of ejector cylinder	3ft
Combined power of two drawback rams	300 tons
Stroke of drawbacks	8ft
Power of slide moving cylinders in either direction	50 tons
Stroke of slide moving cylinders	12ft 6in

The top table is connected by four 16in diameter columns to the moving crosshead, and its underside is machined, drilled and tapped to take a steel bolster plate. The columns connecting the top table to the crosshead are of forged carbon manganese steel machined to a high finish all over and provided with buttress threads at the ends for split cast steel nuts. In the steel casting forming the moving crosshead cored holes house the six main hydraulic cylinder assemblies and the two drawback cylinders. A hole in the centre provides clearance for the ejector cylinder assembly fixed on the underside of the main table.

Each of the main hydraulic rams is made of Meehanite iron and has a "Fescolised" nickel deposit with a ground finish. The hydraulic cylinders are of forged steel construction with open-end flanges for attachment to the crosshead, and machined strips fitted for adjustment purposes on the outside of the cylinders mate with fitting strips in the bores. The packings used on the cylinders are suitable for operating with lubricated water as the pressure medium,

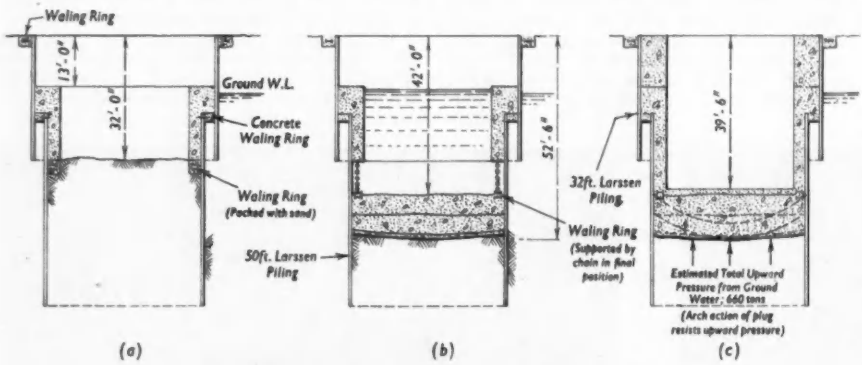


Fig. 3—Three final stages in construction of the pit for 2000-ton press

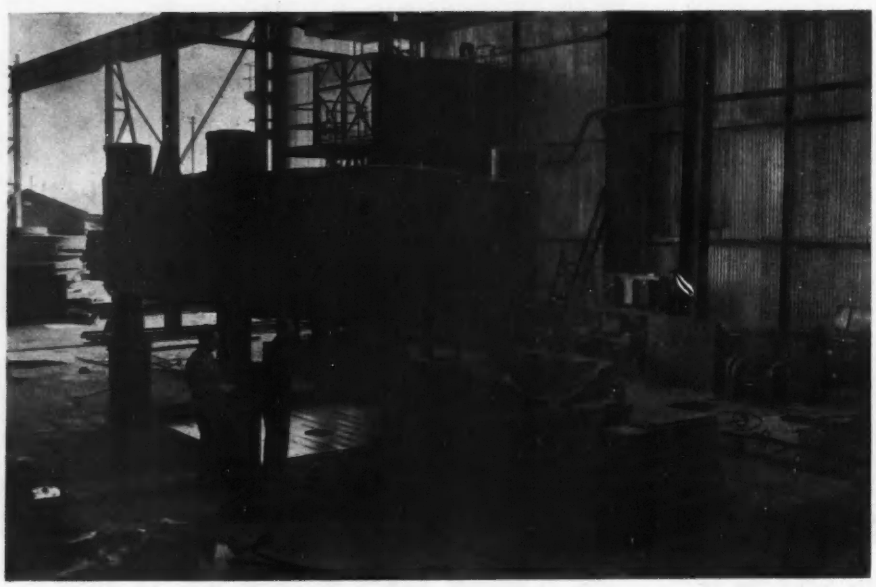


Fig. 4—2000-ton press with anvil slide withdrawn

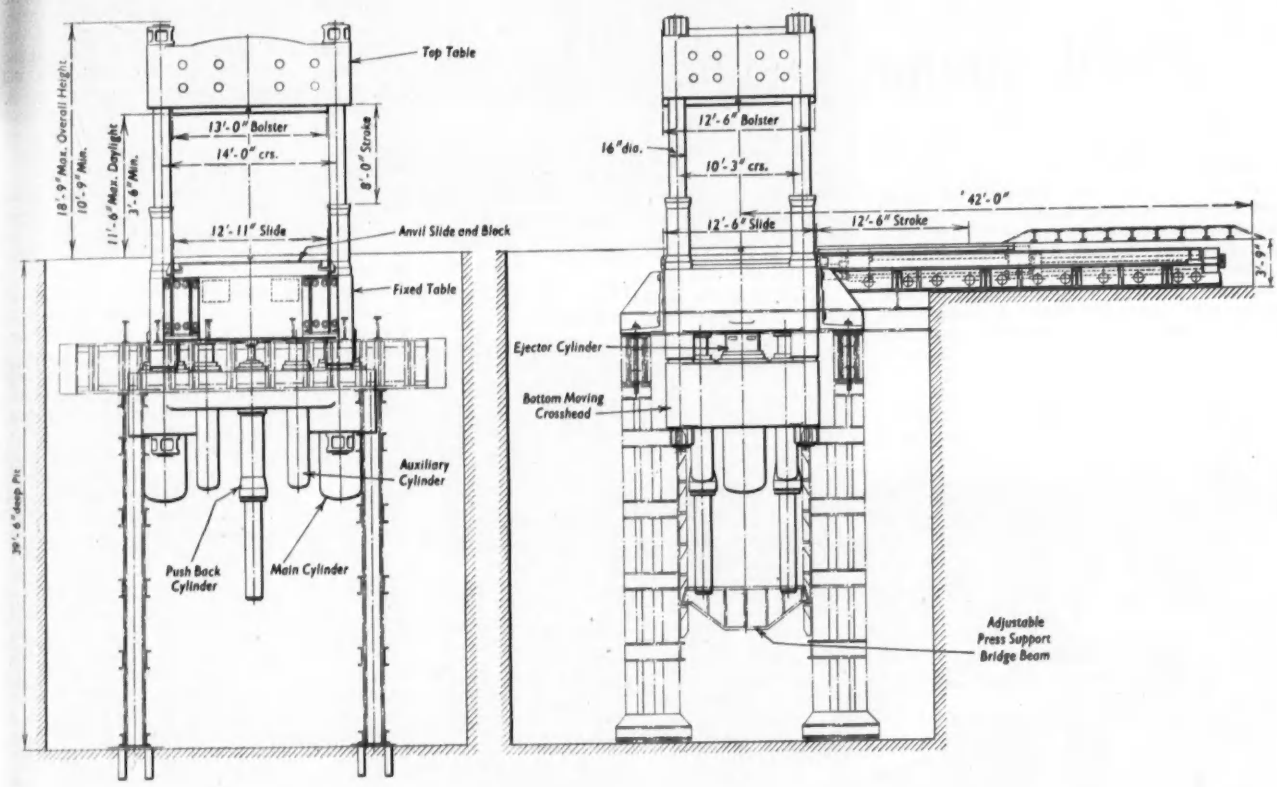
and the gland and neck bushes and packings are retained in position by massive steel gland rings studded to the cylinders. With the hydraulic control arrangement used the four small inner cylinders can be used in forging work calling for pressures of up to 667 tons, or the two large outer cylinders for work up to 1334 tons, over the full stroke of the press. For the heaviest classes of work the six cylinders can be operated in unison to give a total pressure of 2000 tons.

The two drawback cylinders have differential rams, the ends of which are reduced in diameter for connection to the underside of the table. A single combined ejector and stripping cylinder supported by a shoulder from a recess in the main table exerts an upward thrust of 400 tons over a stroke of 3ft, and it has an additional stroke of 4ft, while it exerts a thrust of 50 tons which can be used to good advantage for accurate plate setting before processing.

The end of the forged steel bottom bolster plate or slide plate on the main table is machined and tapped for connection with the anvil slide at the side of the machine. The surface on which the anvil slide moves is provided with phosphor-bronze wearing strips and the plate is retained on the bolster by steel strips fitted with gunmetal wearing strips. Two hydraulic cylinders used for actuating the anvil slide over a stroke of 12ft 6in have fixed rams and they are fitted with valves to cushion the slide cylinder crosshead as it comes up to stop at the end of its inwards and outwards movements.

The balanced mitre-seated valves used for the press movements are controlled by hand levers operating through hydraulic servo gear. These control levers, together with the necessary indicating instruments, are mounted on a control desk in a convenient position at the side of the machine from which all movements can be clearly seen by the operator (see Fig. 5). All the main cylinders are fitted with prefilling valves by which, on the last closing stroke, the cylinders are filled from a 2000 gallons supply tank. The control valves and the filling valves are proportioned to give the press an approach stroke speed of about 6in a second ; a pressing stroke of about 1in per second ; and a return speed of 8in per second. All moving parts of the press are automatically lubricated from a central equipment supplied by Farvalube, Ltd.

The top of the pit round the press table is covered at floor level with removable plates, and a stairway down one side of the pit gives adequate access to the hydraulic and other equipment for maintenance purposes. Although these plates can be removed to provide crane hook access to the pit special provision had to be made to allow the dismantling of the lower moving crosshead or hydraulic equipment for major overhaul or



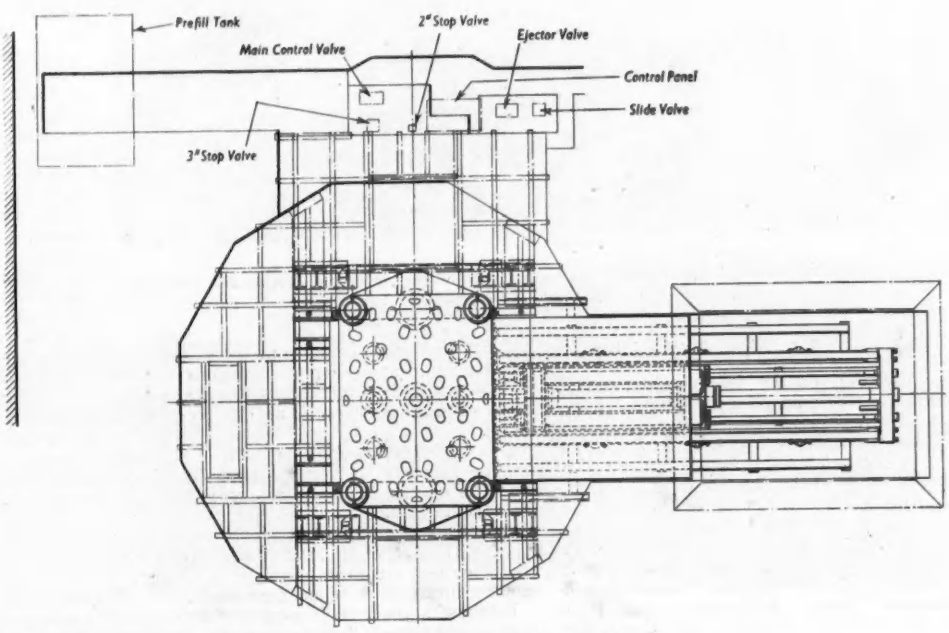


Fig. 6—Arrangement of 2000-ton down-stroking forging press with anvil slide

other purposes. For this reason supplementary columns have been fitted to the sides of the main support columns, as can be seen in Fig. 6. These supplementary columns face one another and have spaced up their height a series of brackets, on which can be located special bridge beams. The lower crosshead can be lowered to rest on these beams, which are capable of supporting the weight of the entire moving assembly. Then by the use of special equipment any part of the press can be removed and lifted out of the pit by the shop crane in the normal way.

As part of the press installation the new overhead crane serving the shop has a capacity of 85 tons in order that it can handle, when required, the heaviest of the press parts. Normally this crane will have an operating capacity of 30 tons, but the three sections of its gantry immediately adjoining the press site are reinforced to comply with the maximum loading requirements. This crane gantry was also extended beyond the doors at the end of the shop and a special supplementary door has been fitted to retract back along the underside of the roof to prevent undue heat loss during forging operations.

The furnace which has been installed by the Dowson and Mason Gas Plant Company, Ltd., to serve the press is fired by gas oil by four Laidlaw Drew low-pressure oil burners. Its hearth, which is 16ft long by 15ft wide, is provided with a 16ft by 13ft bogie, and the furnace is controlled by a "Kent" Mark 20 fully-floating temperature and pressure control unit. Gas oil for this furnace is stored outside the building in a 15,000-gallon tank fitted with a twin pumping set and arranged for filling from either road or rail tank vehicles. There is sufficient room for the installation of a second furnace at some future date, if required.

Royal Aircraft Establishment

TO celebrate its golden jubilee, the Royal Aircraft Establishment, Farnborough, held open days on Thursday, Friday and Saturday of last week, and an exhibition of flying and of work at the Establishment was organised. All but the most secret departments of the Establishment were thrown open and each attempted to illustrate the evolution of that part of aeronautics for which it is concerned. Particular emphasis was naturally placed on the present state of development and a great deal of ingenuity was shown in the dynamic models made to illustrate working principles.

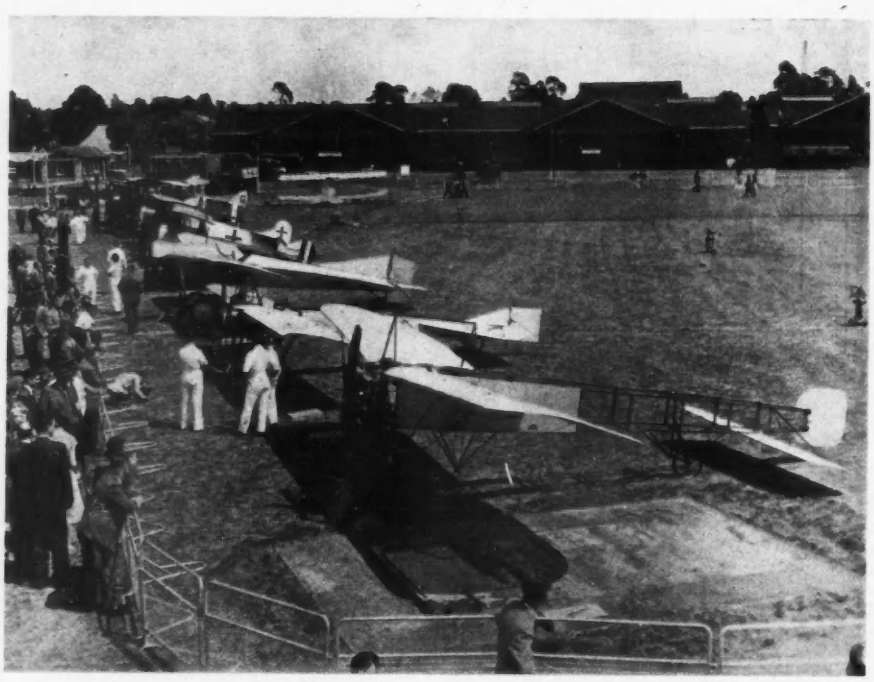


Fig. 1—Some of the vintage aircraft which joined in the flying display, with the Bleriot and Blackburn monoplanes in the foreground

The evolution of the fighting aircraft was excellently demonstrated by participants in the flying display itself. The first Bleriot and Blackburn monoplanes, Fig. 1, gave a low level flying demonstration and a Bristol fighter and a Sopwith biplane of the first world war indulged in a mock dog-fight. Aircraft of the inter-war period were represented by such machines as the "Hart," "Gladiator" and "Swordfish" which flew in formation. Such veterans of the last war as the "Lancaster," "Beaufighter," "Mosquito" and "Wellington" had their turn, and finally, though more reminiscent of the familiar post-war Farnborough air displays, came the jet aircraft. This flying display was also distinguished by the first appearance at a public function of the English Electric "P.1.", the first aircraft in this country capable of exceeding the speed of sound in level flight. A crash marred the flying display on Thursday when a "Hunter" seemed to suffer from engine failure after take off. The pilot was killed.

Apart from the individual static exhibitions within the departments themselves a central exhibition was arranged in one of the main hangars illustrating items from the whole field of aeronautical development undertaken at Farnborough. It need hardly be said also that much of the current work at Farnborough is secret.

One of the more important items of research at Farnborough in recent years has been its work on the fundamental and engineering aspects of fatigue and the development of titanium alloys for use in the structure of supersonic craft. These metals have higher corrosive resistance and are much stronger at "warm" temperatures than the aluminium alloys.

Exhibits in the metallurgical section suggest that the last stage in the long struggle to establish the mechanism of fatigue is at hand. We learned that, working with aluminium alloys, the metallurgists at the R.A.E. believe that cyclic loading induces much the same condition in the crystal lattice as excessive heat treatment. Across planes in the lattice, distortion brings about local heating, and excessive precipitation occurs, rendering the metal, thus depleted of its solute elements, softer and consequently weaker. This soft constituent is then progressively extruded, as the number of reversals grows, in thin ribbons from the surface, leaving cracks or fissures in the crystal lattice. It follows that the cycle is self propagating, for as the metal softens in the affected regions the load on neighbouring regions must progressively increase, and the resulting crack itself contributes further to the local stress concentrations by reason of its root geometry.

On display were microphotographs showing these metal ribbons being extruded from the surface of an actual light alloy specimen. We learned also that it may well be that the theory applies to all metals whether there is a solid solution phase or not, i.e. that the heating and softening process due to lattice distortion will remain an inherently weakening one in metals. No matter how the microstructure of a metal is arranged by the metallurgist it would seem that its eventual failure by fatigue under cyclic loading must be accepted.

From this theory it seems logical that under hotter conditions, which increase the atomic mobility, the above process, as with all diffusion mechanisms, becomes more rapid and the fatigue life is much shorter.

Apart from such fundamental avenues of research, Farnborough is engaged upon more immediate engineering aspects of the problem. By far the major part of its research programme is based upon the titanium alloys. A significant point about the test specimens used is the fact that in most cases the specimen is in strip form with a hole of about $\frac{1}{8}$in diameter in the waist. This is to introduce the effects of stress concentration caused by rivet holes which makes the test condition more nearly approach the actual working conditions in an aeroplane. Stresses up to three times the normal are experienced at the periphery of the hole.

Much work is also being carried out on notched specimens turned from bar stock. The "notch" is in fact nothing more than a surface scratch being 0·008in long with a root radius of 0·004in, having a stress raising factor of three at the root. Batteries of conventional Haigh direct stress electromagnetic fatigue testing machines were shown during the exhibition. These work up to 6000 c/s, some being equipped with split furnaces for high temperature fatigue loading. A film showing the development and propagation of a fatigue crack was shown to visitors. Farnborough is also proud of the fact that the preparation of the first piece of titanium metal in Britain was done in its metallurgy department.

Corrosion particularly with regard to its influence on crack propagation and fatigue is another subject of current high priority research. For instance, working in vacuum and in protective atmospheres test pieces are exhibiting much greater lives. The array of equipment for metallurgical research at Farnborough includes the use of radioactive tracers, X-ray machines, X-ray diffraction cameras and electron microscopes.

The attainment of very high temperatures by high-frequency induction heating was illustrated in the course of hot pressing zirconium carbide. The high strength and ductility of molybdenum at elevated temperatures—it is superior to all metals and "ceramets"—is nullified by its catastrophic oxydisation rate. Considerable success has been achieved very recently by different groups of workers on coating molybdenum with an oxydisation coating, usually a "ceramet." The R.A.E. was showing some coated heating elements in molybdenum maintained at 1200 deg. Cent.

The metallurgical department has also produced very recently two very important titanium alloys—titanium-vanadium and titanium-molybdenum, the properties of which were described at the exhibition. The alloying constituents are up to 16 per cent and the maximum tensile strength are as high as 88 tons per square inch, which is twice that of the

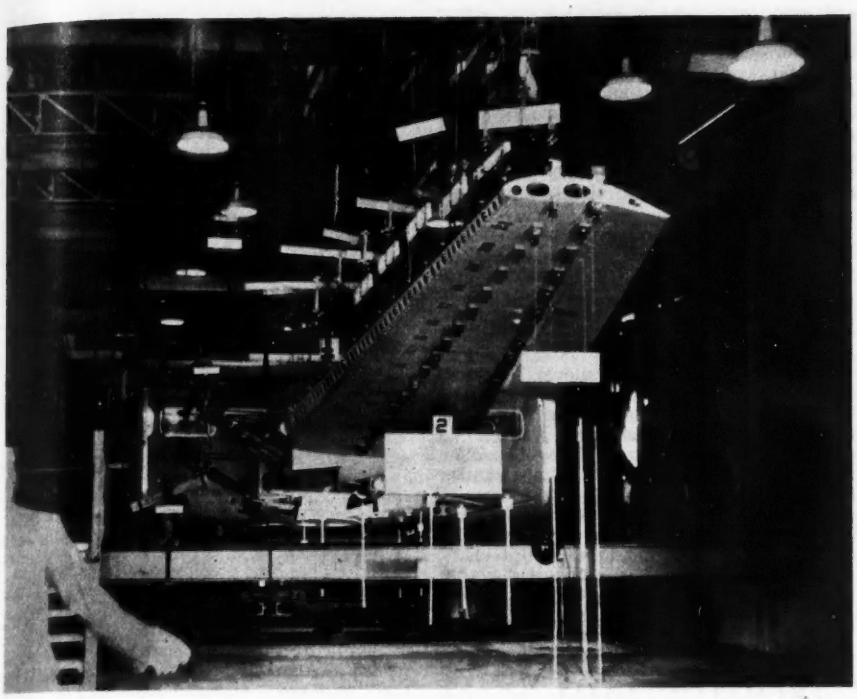


Fig. 2—The " Cathedral " test rig

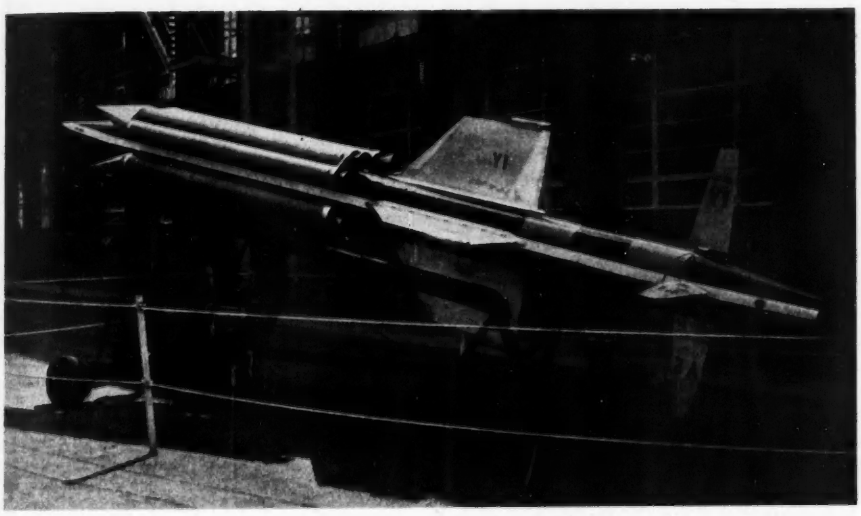


Fig. 3—One of the latest controlled rocket test vehicles

aluminium alloys. Both alloys retain particularly high strength at temperatures up to 400 deg. Cent. Both alloys have been developed to meet the kinematic heating conditions to which supersonic aircraft structures are submitted. Their advantage over the alternative stainless steels springs from their somewhat greater strength and the fact that they are only about half the weight. They have the disadvantages of a relatively low Young's Modulus rating.

While the importance of the ceramic group of high temperature materials is fully realised in Britain, most of the research has been farmed out to industry and to other national research establishments. Very little work was shown at Farnborough. Other important developments in the metallurgical field are new processes to cut the cost of titanium sponge and powder. There were schematic diagrams of a vaporising process using chlorides for the reduction of ferro-titanium which is the commonest and cheapest form in which the metal occurs. At present most titanium is reduced from its oxide. The other reduction process illustrated is electrolytic.

Kinematic heating arising from flight at supersonic speeds has already been mentioned. The difficulty in assessing the stress systems developed arises from the fact that, until recently, it was extremely difficult to simulate the heating conditions on a scale model, since the worst condition is a transient one and is consequently a function of time.

The major obstacle was that of obtaining a heat source which could be precisely located and controlled. Such a source was not available until Philips developed a quartz tubular infra-red heating element. These units take the form of tubes $\frac{3}{8}$in diameter by 14in long, having outputs of up to 3kW. An instrument capable of precisely measuring the heat flux with a near instantaneous response was developed at Farnborough. The flux meter incorporates a thermistor bead as the sensing element, and the characteristics of this semi-conductor are such that its resistance drops from 2000 ohms to 600 ohms when the loading increases from 0 to 4 watts per square centimetre. The response has a delay of less than 1 second.

The final element on this equipment is an electronic computer. Into this are fed the aerodynamic factors determining the heat demand and at the other end the heat input as converted by the flux meter. The task of the computer is to equate the heat input to the heat demand.

The thermal strains are measured with conventional strain gauges. One of these installations was demonstrated to visitors and alongside was a model structural test rig with these heating elements disposed over the wing skin of an aircraft with a Mach. number 3.

The dominating installation in the structural testing laboratory is the " Cathedral " test frame (Fig. 2) which is one of the largest in Europe. This large and very rigid frame is capable of handling the wing of the largest aircraft and to test it to destruction under static loading condi-

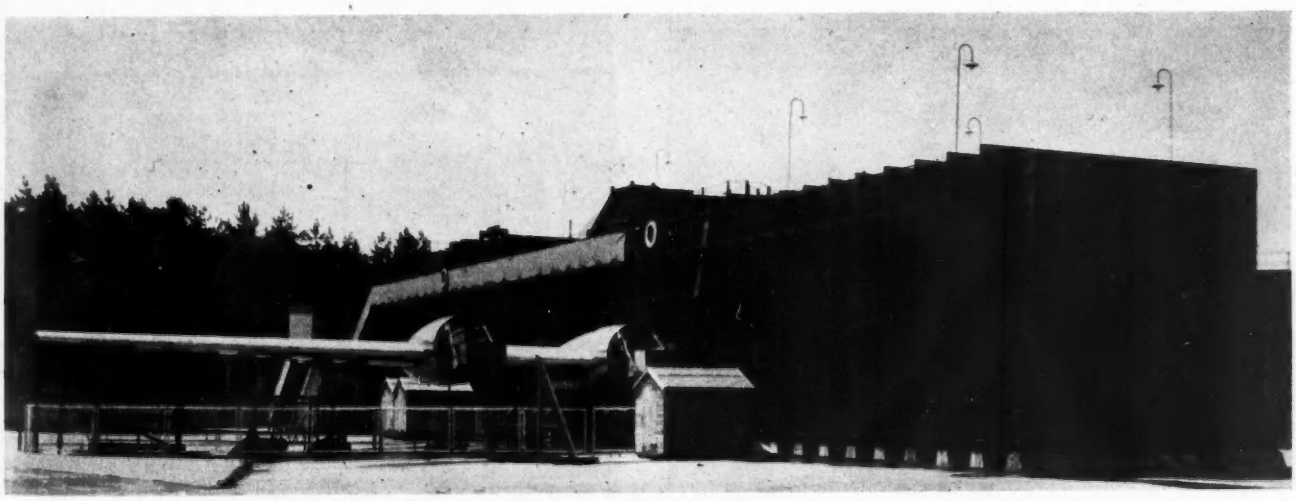


Fig. 4—A Bristol " Britannia " is shown in the flight-simulating rig which is similar to that used on the " Comet "

tions. We learn, however, that it is now too small to handle the larger swept-back wings simply because of their configuration rather than their size. A new structure has now been designed which will not be so compromised by wing geometry. A number of exhibits displayed in this laboratory illustrated the evolution of aircraft and component design in the last fifty years. One of the more important services to aviation development which Farnborough has given during these years has been its work on accident investigations and the techniques developed whereby what scant remains there might be in a burnt out aircraft can be made to reveal the cause of the disaster. Examples of its work in this field were illustrated.

A number of special techniques used in experimental biaxial stress analysis were also demonstrated. Apart from the more familiar photoelastic techniques using special resin scale models, the brittle coating technique developed at Farnborough was also demonstrated. With this system the surface stress distribution of an actual component of structure can be visualised and determined. Some of the equipment for applying the brittle coating was displayed together with that for assessing the performance of the coating.

Another major problem concerning the structural department is the investigation of flutter and other vibrational problems arising either in the airframe or the propulsion mechanism in the air or on the ground. Equipment and techniques for exciting these disturbances were shown. Methods of mounting and locating inertia exciters for airborne testing were shown. A new form of exciter was also shown. It consists of cordite capsules which can be located about the wing and detonated electrically. The firing order is phased to suit the vibratory mode required.

Few new details of progress in guided missile development were given. There were plenty of missiles shown (Fig. 3), but all were control test vehicles (C.T.V.), general test vehicles (G.T.C.) and power units to propel free flight models of supersonic craft. The de Havilland infra-red air-to-air missile was not shown. Nor were any other "near operational" missiles.

Amongst other items of engineering interest we noted the seals which are used to seal the turbine bearings absolutely from leaking into the hot zone down the shaft. They depend on the shaft speed to centrifuge the oil into annular collectors.

There are now three full-scale water tank pressurisation fatigue test rigs. Out of one of these the wings of a Mark 100 "Britannia" protrude (Fig. 4). By last week, this aircraft had undergone 3000 complete flight cycles.

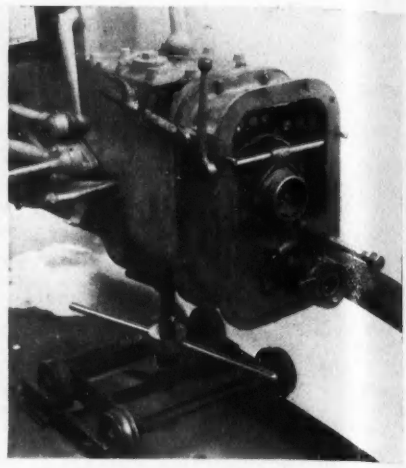


Fig. 14—Combined epicyclic reduction and live power take-off unit

Royal Show at Nottingham

No. III—(*Concluded from page 39, July 8th*)

THE Royal Agricultural Society's annual show, which was held at Wollaton Park, Nottingham, last week, ended on Friday evening, and from most aspects is to be considered one of the most successful of its kind. The weather throughout was excellent, the ground and the setting for the show were particularly pleasant, and the total attendance was the highest since 1949. The number of paid admissions in the four days of the show last week was 185,527, compared with 143,045 last year and 108,677 (on five days) when the show was last held at Nottingham in 1928.

As has been particularly noticeable at each Royal Show in the years since the war, there was keen interest in the exhibits on the 600 or so machinery and equipment stands. Much that was exhibited is familiar to all who endeavour to keep abreast of agricultural engineering development; but, in matters of detail, there were many improvements to existing machinery to be noted, and there were several new machines and other items of equipment that were on show for the first time. It is principally with those that we deal in this concluding article on the show.

A device designed to give extra efficiency in the operation of Ferguson tractors was shown on the stand of Massey-Harris-Ferguson (Sales), Ltd., Coventry. It is a combined speed reduction and live power take-off unit (Fig. 14), which is fitted between the transmission and back axle centre housings of the tractor. This device provides the Ferguson "TE" and "TO" tractors with four additional low forward speeds and a second low reverse speed, and enables the power take-off to be maintained in operation whilst disengaging the drive to the tractor's rear wheels. The unit consists of an epicyclic gear train giving a 3 : 1 reduction, and when it is engaged the additional speeds made available are :—

Engine (r.p.m.)	Speeds (m.p.h.) 1st	2nd	3rd	4th	Reverse
1000	0·55	0·77	1·06	2·2	0·64
1500	0·83	1·15	1·58	3·3	0·96
1750	0·97	1·34	1·85	3·85	1·12
2000	1·11	1·53	2·11	4·4	1·28

Two levers only are necessary for operating the reduction unit, the selector lever engaging the gear, and a control or clutch lever establishing the drive. These levers interlock to ensure their operation in the correct sequence.

New mounted implements for the Ferguson tractor, which were exhibited at Nottingham, included a welded steel transporter of 1 cubic yard capacity and capable of handling loads up to 7 cwt, and a kale cutrake. Kale is used in large quantities for cattle feeding and cutting and carrying it by hand can take up many man-hours. The tractor-operated cutrake, illustrated in Fig. 12, has been produced with this in mind; the tractor is reversed into the crop and the implement cuts the kale, which is carried on the rake to wherever it is required. The cutrake is built of steel tube and plate, its tines having welded inserts at each end for attachment to its main frame and to the cutter-bar, which is similar to that of an ordinary mower. Bull-nosed fingers are fitted on the cutter-bar to prevent "spiking" of the kale, and the knife is driven from the tractor's power take-off shaft through a pitman drive and a pivoting lever situated at the centre of the implement.

A new machine for cleaning ditches (Fig. 15) was shown by Barford (Agricultural), Ltd., Belton, near Grantham. It is known as the "Lincol" ditch and dyke cleaner and has been designed for attachment to a David Brown 30 I.T.D. crawler tractor, which has track widths of 13in with 56in centres. A specially designed gearbox has been incorporated in the tractor to provide the slow forward speed necessary for operating the ditch cleaner; the normal travelling speed in work is about ½ mile an hour with the tractor engine running at 1600 r.p.m. As will be noted from our illustration, the cleaner is attached to the side of the tractor by a steel frame, the digger chain being mounted on double rollers and equipped with hardened steel tines. The lifting mechanism is hydraulically operated by a single-acting ram powered by a hydraulic pump which is situated on the front of the tractor and driven direct from the engine crankshaft. The control valve for the hydraulic system is mounted on the oil supply tank, its control lever being conveniently placed for operation by the tractor driver. The drive to the digger is taken from the tractor power take-off shaft through a spring-loaded clutch which

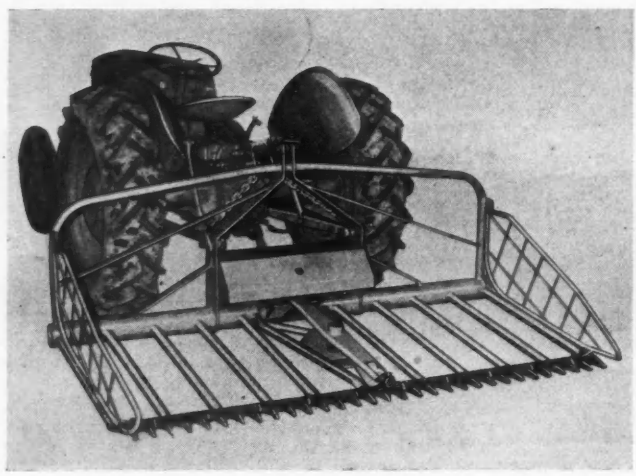


Fig. 12—Tractor-operated rake for cutting and carrying kale

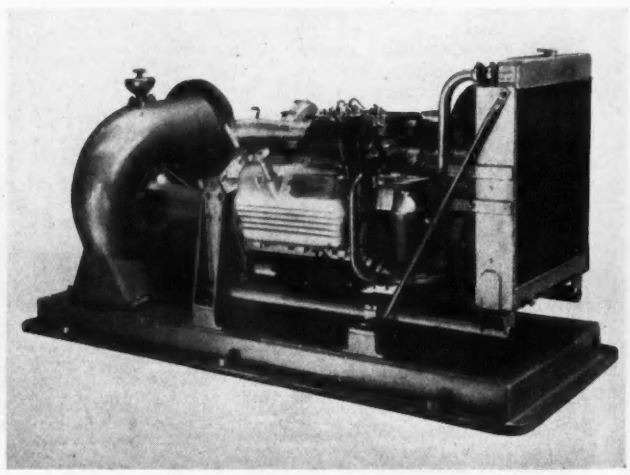


Fig. 13—Pumping set incorporating 66 h.p. three-cylinder diesel engine

transmits the required power, but which will slip when overloaded. The ditch cleaner can operate to a depth of 3ft 6in, and the rollers which carry the digging chain can be adjusted to suit the shape and contour of the ditch. The tractor is placed parallel with the ditch and the digging chain lowered until it touches the bottom. The power take-off is engaged with the tractor in bottom gear, the master clutch is operated and the tractor moves forward with the digger in work. As the spoil is lifted it is evenly spread between the edge of the ditch and the tractor.

Another interesting exhibit by Barford (Agricultural), Ltd., was a soil sterilising equipment consisting of a boiler and a soil container. The boiler normally used for this system of soil sterilisation is an "Invicta Major," which is 5ft high and 2ft in diameter, and which gives from 150 lb to 180 lb of steam an hour. The container can be made of brick, cement or wood, and the example exhibited was 4ft long, 2ft 3in wide and 9in deep, capable of containing about ¼ cubic yard of soil. The steam is injected into the soil by a perforated pipe grid drilled with rows of ⅛in diameter holes. The grid is fitted with a drain cock to remove any condensate that may form in the pipes, and the floor of the container is sloped a little to assist the drainage of moisture from the soil.

As is usual at the Royal Show, there were to be seen on several stands examples of portable and stationary oil engines suitable for many agricultural and outdoor applications. A new diesel engine, exhibited by R. A. Lister and Co., Ltd., Dursley, Glos, is illustrated by Fig. 13, in which it is shown coupled to a Sigmund pumping set. This engine, designated the "TS3," is a joint product of the Rootes Group and R. A. Lister and Co., Ltd. It is a two-stroke, opposed-piston engine with three cylinders, 3·25in bore and 4in stroke, and has a maximum output of 90 b.h.p. at 2400 r.p.m., the maximum torque being 250 lb-ft at 1200 to 1500 r.p.m. It is stated that the engine develops its rated power of 66 b.h.p. for twelve hours continuously, including 10 per cent overload for a period not exceeding one hour. The porting is based on the Kadenacy principle, and there is a Roots blower to assist scavenging. As to the operational cycle of the engine, each of the three horizontal cylinder liners is equipped with two pistons, which move to and fro along the bore in opposite directions, one piston controlling the inlet ports and the other the exhaust ports. As the pistons approach mean inner dead centre both the inlet and exhaust ports are sealed. Fuel is then injected into the combustion chamber, formed by the space between the respective piston crowns, from the injector nozzle located on the centre line of the liner. Because the combustion space already contains air at a very high temperature—by virtue of it being compressed by the converging pistons—the fuel is ignited instantaneously and combustion takes place, the high pressures generated forcing the pistons outwards on their working stroke and so actuating the linkage to turn the crankshaft. Towards the end of the working stroke ports in the liner wall are uncovered by the exhaust piston and burnt gases are allowed to escape into the exhaust pipe. Shortly afterwards the inlet piston uncovers the air ports, and air held in the chest surrounding them rushes into the cylinder, driving any residual gases before it into the exhaust system, and in this way scavenging is achieved. In order that a small additional build-up of air within the cylinder can take place to ensure complete combustion, the exhaust ports are arranged to close a brief period before the inlet ports. The pistons then converge towards mean inner dead centre and the whole cycle is repeated.

Some new engines were also shown by Ruston and Hornsby, Ltd., Lincoln. They included the "YC" class of four engine sizes providing powers from 16 to 72 b.h.p. The "YC" is a four cycle diesel engine with open combustion chamber and direct injection. The four models are two, three, four and six-cylinder units respectively, and the engines have been designed for stationary, portable or mobile operation. Another new engine exhibited by Ruston and Hornsby, Ltd., was the "HRO" horizontal oil engine, which is available is sizes from 5½ to 24 b.h.p., with speeds ranging from 350 to 550 r.p.m.

Among the many items of smaller tractor-mounted equipment which we noted during a tour of the show was a "broadcaster" (Fig. 16) for fertiliser, seed, or for such materials as sand and small gravel. It was exhibited by E. V. Twose (Manufacturing), Ltd., Lowman Works, Tiverton, Devon. The broadcaster, which can be mounted on a tractor having a three-point linkage, incorporates its own stand, above which there is a steel plate hopper of 5 to 8 cwts capacity. There are very few wearing parts; the drive for "broadcasting" comes from the tractor power take-off and is transmitted to the spinner plate just underneath the hopper by a friction disc. All the revolving shafts are fitted with roller bearings, and the rate of flow is regulated by a feed gate controlled by a lever within easy reach of the tractor driver. The normal spread of the broadcaster is 35ft.

Among numerous other items of small equipment at the Royal Show, there were motor scythes and other kinds of mowers which are particularly useful in large gardens, smallholdings, sports grounds and similar places. John Allen and Sons (Oxford), Ltd., Cowley, Oxford, has this year added to its products of this nature the handle-bar controlled rotary sickle shown in Fig. 17. It is designed to deal with rough growth and has a cutting width of 22in. The machine is built on a pressed steel frame, and is powered by a Villiers Mk. 25C two-stroke engine. The drive to the cutter is by straight vee-belt through totally enclosed bevel gearing. The drive to the road wheels is taken by vee-belt and roller chain reduction gear. Two clutches are provided, one controlling the machine's forward motion, and one the spinning cutters. Thus, by engaging only the clutch controlling the travel, the machine can be moved from place to place under its own power without the cutting mechanism revolving.

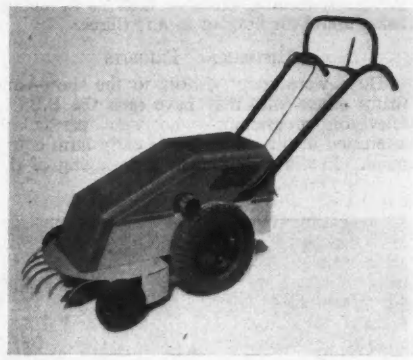


Fig. 17—Self-propelled rotary sickle

The engagement of both clutches converts the machine into a self-propelled cutting unit. There is a conveniently situated kick starter, and a close-fitting cowl protects the engine and the whole mechanism from dust. The handlebars give a comfortable working position, and have a built-in extension to allow the front of the machine to be raised when dealing with extra tall growth.

Silver Medal Awards

Throughout our articles on the Royal Show, we have made reference to exhibits accepted for adjudication for the silver medals awarded annually by the Royal Agricultural Society. These awards are made for "new implements" for agricultural or estate uses. The judges this year were Mr. Leslie Langmead, Mr. Rex Patterson, and Mr. A. G. Wright, and nineteen entries were finally accepted by the Society's machinery committee. Silver medal awards were made to John Wilder, Ltd., Wallingford, Berks, for a tractor-operated straw chopper (in respect of which the Burke trophy was also given); to E. Allman and Co., Ltd., Chichester, for the sheep spray-race (described in our last issue); David Brown Corporation (Sales), Ltd., Meltham, Huddersfield, for the traction control unit (described in The Engineer of December 10, 1954, and July 1, 1955); D. McMaster and Co., Ltd., Bures, Colchester, for an automatic pig feeder, and to E. H. Bentall and Co., Ltd., Maldon, Essex, for a protein extraction plant. This last-named plant has been designed for the mechanical extraction of protein from any kind of green vegetable matter. Briefly, what happens is that the raw material is first of all fed into a "pre-chopper" and then carried to other parts of the apparatus where, by compression, its cellular structure is broken down and a high proportion of the juice extracted. The remaining fibre can then be passed through a washer and through a second compressor. The final protein product is known as "Protess" and is suitable in its various forms for animal

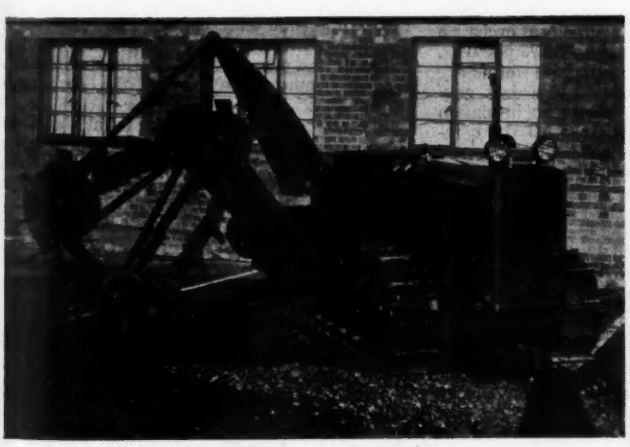


Fig. 15—Ditch cleaner mounted on the side of a crawler tractor

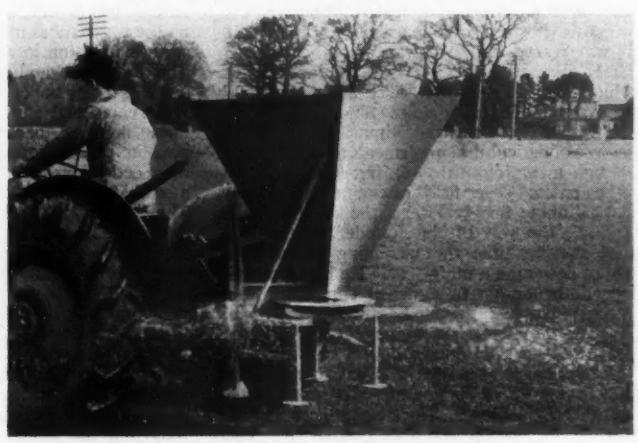


Fig. 16—Tractor-mounted "broadcaster" for seed or fertiliser

or poultry feeding, the fibre, after its extraction, being useful for litter or as a fertiliser.

Historical Exhibits

There were many visitors to the show—and many others who may have seen the B.B.C.'s television programme—who were particularly interested in the exhibition of early farm equipment. In the arrangement and staging of this special exhibition, the Royal Agricultural Society was ably assisted by Mr. John Higgs, Keeper of the Museum of English Rural Life, Reading.

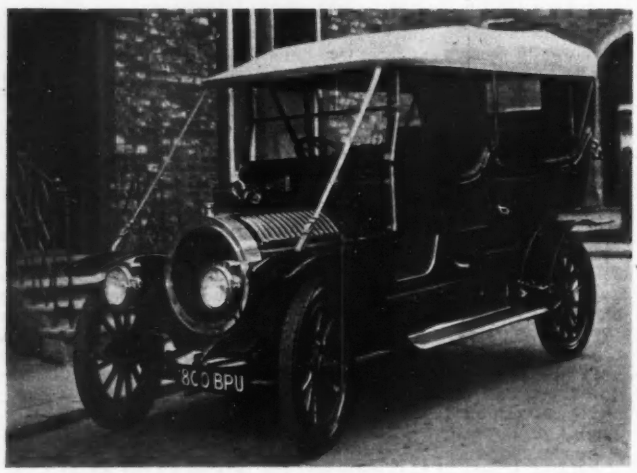


Fig. 18—Motor-car built in 1908. The four-cylinder engine was designed to develop 16-20 h.p.

The display included some of the machines which were introduced into farming between the first Royal Show at Oxford in 1839 and the first visit of the show to Nottingham in 1888. The centre-piece, in fact, was a reconstruction of a section of the 1839 show yard, with some implements of the kind exhibited there. There was a winnowing machine, as sold by Joshua Cooch, of Harlestone, to Earl Spencer, who was the first president of the Royal Agricultural Society. There were also some old ploughs, including two provided by Ransomes, Sims and Jefferies, Ltd., Ipswich, who received the first gold medal awarded by the Society in 1839. There was a selection of farmhouse utensils, an example of a nineteenth century farm wagon, and various other horse-drawn vehicles of the kind that would have been used by visitors to the Royal Show in 1839. In addition, there was a pair of steam ploughing engines, made by John Fowler and Co., Ltd., Leeds, in the 1880s, together with a cable-operated cultivator or "scarifier" as it was commonly known. The engines were steaming; they were lent for the occasion by Beeby Brothers, Kempstone, Loughborough, who, we understand, are still working them.

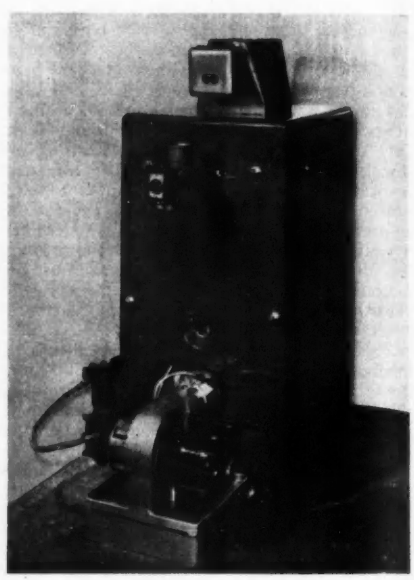
There were some interesting historical exhibits in other parts of the show, and one of them was the motor-car, now nearly fifty years old, which is shown in our final illustration, Fig. 18. It was placed at the entrance to the stand of E. H. Bentall and Co., Ltd., Maldon, Essex, which firm is this year celebrating the 150th anniversary of its foundation. Since its beginning, the firm has been engaged primarily in the manufacture of agricultural implements and machinery, though at various times during its long career it has entered other fields of engineering activity. Round about fifty years ago, the late Mr. E. E. Bentall, the son of the founder of the firm, and at that time the managing director, set about designing a motor-car. He had just completed the design of a petrol engine for farm use. When Mr. Bentall began to work on his car, automobile engines were made with separate cylinders, and his engine design was based on that principle. But just as the car was about to come into production the monobloc system came into fashion! Then, too, there was the system of horsepower tax devised for cars, which was based on cylinder diameter, and which was introduced after the Bentall engine had been designed. But despite these setbacks, E. E. Bentall went ahead with his car production and between 1907 and 1910 about 100 were built. There were four models, the smallest a twin-cylinder 8 h.p. (of which only two were built), and 11 h.p., 16 h.p. and 16–20 h.p. models. The car exhibited was in the 16–20 h.p. category, the engine having four cylinders, 100 mm bore by 95 mm stroke. This particular car was taken by its original purchaser to Ceylon. Two or three years ago it came to light in Dorset where it was still being used, in a somewhat dilapidated state, for several odd jobs about a farm. The firm was able to acquire it, and at the Maldon works it was restored. Mr. Ernest Linnett, who spent the whole of his working life with Bentall's, and who was formerly chief engineer of the car department, came out of retirement to undertake the task of restoring the car to its original state. It is noteworthy that Mr. Linnett had no need to refer to the original plans; he remembered clearly all the engine and other details. Recently, the car was driven from Maldon to Edinburgh, where it appeared at the Royal Highland Show, and then back to Nottingham. On the Maldon-Edinburgh trip, we understand, it did 16 miles to the gallon.

Small Oil-Fired Boilers

With the expanding supplies of oil fuel and improved distribution making small quantities available, the Gas Division of Thomas De La Rue and Co., Ltd., decided to extend its "Potterton" range of boilers to include oil-fired units suitable for central heating and direct hot water supply in a large number of establishments. As a result of the decision four boilers, marks DOA 3, 4, 5 and 6, one of which we illustrate, are now available, the respective outputs being 108,000, 144,000, 180,000, and 216,000 B.Th.U. per hour, and the corresponding oil consumption being 0·84, 1·12, 1·40, and 1·68 gallons per hour. Later it is intended to introduce larger boilers having an output of 252,000 and 268,000 B.Th.U. per hour. All units are 23in wide by 45½in high, plus 9½in for the flue pipe connection, while the depth, excluding the burner, ranges from 20½in to 38½in.

The boiler consists of standard cast iron waterway sections, which vary in number according to the size of boiler, and which, when assembled, form a combustion chamber with closed base and closed water-cooled sides. Fins on the water tubes provide a large heat exchange surface resulting in an efficiency of 78 per cent. The furnace chamber is lined with refractory brick and the boiler is enclosed in a dark grey stove enamelled steel casing with an insulation lining at front, back and base. All the components of the boiler are delivered to site and the sections, which weigh about 200 lb, are assembled by means of Taylor rings and tie bolts. The "Selectos" oil fuel burner is powered by a ¼ h.p. B.T.H. motor and the fuel, a light oil of 33 to 35 seconds Redwood No. 1, is delivered at 100 lb per square inch by a direct-drive gear pump. There is a filter in the fuel line, another is incorporated in the pump and there is a third filter integral with the single-aperture nozzle. Flue gas temperature is about 400 deg. Fah., the carbon dioxide content being 10 per cent. Maintenance is simple, access to the waterways being obtained by lifting out the side casing sheets and removing the bolted covers, while removal of the front and back casing and insulated end plates gives access to the combustion chamber and flue ways. The burner is on flexible connections so that it can be swung clear.

The pressure jet burner is complete with fully automatic ignition and controls, consisting of a combined flue thermostat and control box and another thermostat in the hot water rising main. All the control gear is supplied by the Danfoss Manufacturing Company and provides a safeguard against the occurrence of irregularities such as ignition failure or fuel stoppage. For starting up the plant the following is the sequence of operations: flame control contacts are placed in the starting position and the green start button pressed, after which the boiler thermostat is set and then oil admitted and the main switch closed to start the burner. Shortly afterwards the ignition relay will trip to interrupt the ignition and the burner will operate normally with intermittent ignition until the boiler water temperature is attained, when the boiler thermostat will cut out the plant. Should the ignition or fuel supply fail when starting up, the safety relay will release in about thirty seconds and stop the plant. This is indicated by a built-in signal lamp and the plant cannot be started until the starter button is again pressed. Should the flame fail during operation there is a drop in the temperature of the flue gases and the motor relay trips and stops the plant. Then, after a purging period of between four to five minutes, to allow unburnt vapour to be dissipated, the plant will start up again automatically. However, should for some reason the flame not be re-established, then the safety relay comes into action within thirty seconds and stop the plant and illuminate the signal lamp. From this position the plant can only be restarted by operating the starter button. Should there be a failure in the electric supply the control restarts the plant automatically when the current is restored.



Small oil-fired boiler

In addition to the boiler, the installation calls for an oil storage tank fitted with a filling line and vent pipe to atmosphere and having a minimum capacity of 150 gallons, mounted in a catch pit of equal capacity, and also a supply line to the burner incorporating a stop valve and strainer and an automatic cut-off valve linked with a fusible plug.

Asbestos Thermal Insulating Material.—We have received from the Cape Asbestos Company, Ltd., 114–116, Park Street, London, W.1, the first of a series of technical data sheets on "Caposite" Amosite asbestos thermal insulating materials. Information is given on the use of these materials as piping, and details are given of specifications for internal and external piping for certain diameters and thermal conductivities.

Central Electricity Authority's Research Laboratories, Leatherhead

A new wing forming an extension to the Leatherhead research laboratories of the Central Electricity Authority was opened by Lord Citrine, chairman of the Authority, on July 5th. This extension provides space for a number of new laboratories and allows for reorganisation of some of the existing ones. The new wing consists of three floors and houses laboratories for generating plant, electrical plant, mechanical engineering, corrosion and metallurgy, electronics and instruments, physics, analytical chemistry and meteorology. With these facilities and the existing high-voltage and low-voltage laboratories and the experimental section of 275kV overhead line, the laboratories are well equipped to carry out research work on the generation, transmission and distribution of electricity on behalf of the C.E.A., its generating divisions and the area boards.

RECENT extensions to the research laboratories of the Central Electricity Authority at Leatherhead were opened on Tuesday, July 5th by Lord Citrine, chairman of the Authority. A press preview on the previous day gave us a brief glimpse of the extensions and some of the work done there.

To appreciate this work some reference should be made to the history of these laboratories, which can be traced back to the establishment of the national grid transmission system by the Electricity (Supply) Act of 1926. Early operational experience on the grid showed the need for a central laboratory to study, at the bench and in the field, the high-voltage transmission problems which were then being faced for the first time in this country. To meet this need the Central Electricity Board established a laboratory at Waddon, Surrey, in 1932. Two years later a high-voltage insulator testing station was started at Croydon to study the performance of outdoor insulators operating in humid and contaminated industrial atmospheres. Through this work the characteristics of insulator flashover in fog were determined and a method was evolved for evaluating the relative merits of various designs of anti-fog insulators. At Croydon, too, apparatus was developed for testing insulators in service. Field work was done on a number of matters including overhead line characteristics, conductor corrosion and radio and inductive interference.

Development of these activities was curtailed by the outbreak of war in 1939, but a small emergency laboratory was opened at Horsley so that some of the work could be continued if the Croydon testing station or Waddon laboratory were put out of commission. On August 15, 1940, the Waddon laboratory had to be evacuated as a result of enemy action and the work was transferred from Waddon to Leatherhead, where there was some vacant space next to the C.E.B.'s 132kV transforming station. Room was also found at Leatherhead for a 250kV test equipment, which was transferred from the more vulnerable site of the Croydon Insulator Testing Station.

With these moves plans were made to build permanent laboratories at Leatherhead, where studies could be made of all the technical problems met in the operation of a large transmission system. Wartime restrictions, however, prevented any action being taken to implement these plans until, with nationalisation of the electricity supply industry, the C.E.B. laboratories became the central laboratories of what was then (April, 1948) the British Electricity Authority. Implicit in this change of title was a change of function, for the laboratories now had to serve the B.E.A. and its generating divisions as well as the area boards, and the scope of its work was extended to include research on the generation and distribution as well as the transmission of electricity.

As far as possible the C.E.B. building plans were modified to suit the new terms of reference. Work on the laboratory building was started in June, 1948, most of the laboratories and office accommodation were in use in 1949, and the building was formally opened on July 15, 1950, by Lord Citrine. Plans were soon made to extend the building to provide improved facilities for tackling the chemical, physical, and mechanical problems encountered in power stations. These extensions came into service early this year and were, as stated above, officially opened on July 5th.

Much of the work of the C.E.A. research laboratories under the director, Dr. J. S. Forrest, consists of *ad hoc* investigations of specific troubles springing from operational difficulties or breakdowns in service. Occasionally, however, the work provides a starting point for a more fundamental piece of research, the outcome of which may, in turn, have further practical applications.

To meet its commitments which are, broadly, to improve the efficiency and reliability of the electricity supply system, the laboratory organisation is based on six subject sections, namely, transmission and distribution, electronics and instruments, generation, mechanical engineering, physics and chemistry. Common services for the laboratories are provided by a drawing-office, a general workshop, a photographic department, a reference library, a reading room, and a conference room.

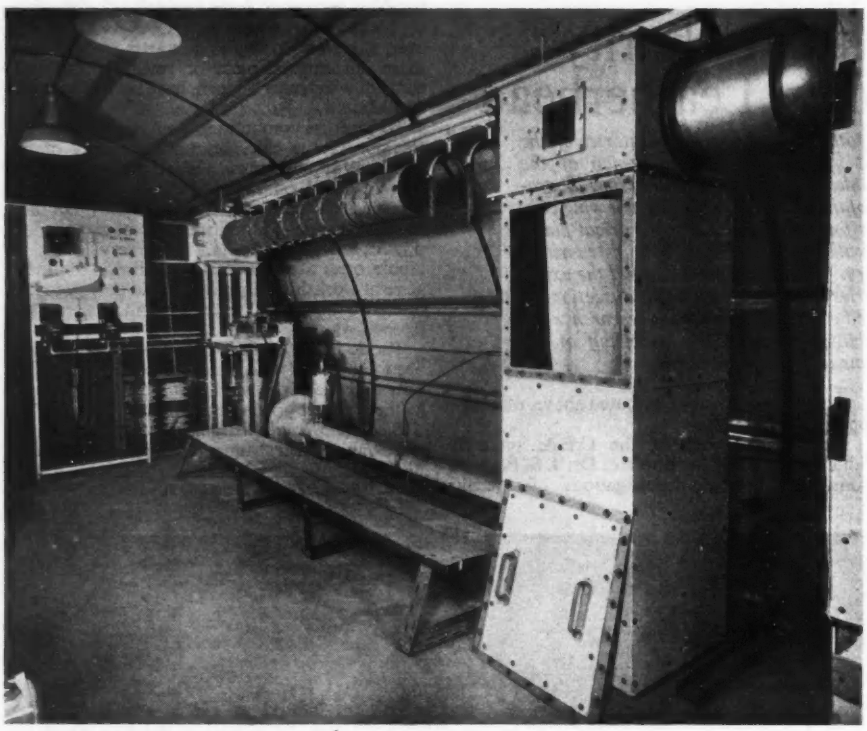
The activities of the establishment have already been outlined,* and here we propose to refer only to some of the work that we saw in progress in the recently opened extensions.

Electronics and Instruments Section.—In the electronics and instruments section the aim is to

* THE ENGINEER, July 28, 1950, pages 102–103

Leatherhead laboratories of the Central Electricity Authority. The new wing is on the right and houses the electronics, mechanical engineering, generating plant and electrical plant laboratories. The transmission test tower is in the background

Part of the electronics laboratory. Work is in progress on v.h.f. radio communication, r.f. interference, surge recording, system protection, and load and frequency controlling apparatus such as might be used on a cross-channel power cable



Electrostatic precipitation pilot plant. Basic work has been done with various forms of central conductor electrode to determine the mechanism of precipitation. Full-scale work is being done at Croydon "B" and other power stations

develop special instruments and apply new electronic techniques to power system operation. Accordingly work is being done on v.h.f. radio communication, recording of surges and thunderstorms, fault recording and power system protection, and control of interference with radio and television reception. Load and frequency controlling apparatus is being developed, with particular reference to the cross-channel power cable project. The operation of a power link of this kind between the French and British electricity systems would necessitate close supervisory control of frequency within 0·01 to 0·05 cycles per second to allow the flow of power to be regulated as required between the two systems. The prototype apparatus which we saw under development in the C.E.A. laboratories consists essentially of rack-mounted electronic analogue computer with facilities for measuring rate of rates of change and for summating changes of frequency and power flow.

Some of the instruments with which the section is equipped—cathode-ray and Duddell oscillographs, apparatus for vibration measurement, frequency meters and time interval meters—have been developed in the section, and there is a specialist workshop for the production of electronic instruments designed in the laboratories. To enable the section to carry out field work there is a mobile laboratory with a photographic dark room trailer.

Generation Section.—The generation section of the laboratories is organised to deal with special problems on generating plant. Much of the work of this section is concerned with the performance of water cooling towers and electrostatic precipitation. Two pilot plants are installed for investigation of the fundamental principles of electrostatic precipitation: in the Leatherhead laboratory there is a concentric tubular precipitator and at Croydon "B" power station the flue gas is passed through a plate type precipitator. In the tubular equipment, illustrated above, work has been done on various forms of central electrode, which is concentric with the outer tubular ducting. With this equipment it is found that almost all the deposit from the "flue gases" takes place in the first few sections of the duct.

Work is also being done on gland seals for high-pressure pumps and a closed circuit hydraulic rig is set up in the generation laboratory so that comparative work can be done on helical, labyrinth and other forms of seals.

One of the problems of power station operation is to dispose of fly ash economically by extracting constituents which may have commercial value; with this in view the generation section is making a study of the prospects of separating and recovering iron dust from fly ash. Preliminary work with a simple apparatus in which fly ash is pumped across a serrated air gap between two magnetic poles has yielded results which are sufficiently encouraging to warrant further study.

Mechanical Engineering Section.—The mechanical engineering section is concerned with a variety of work including measurement of the ultimate tensile strength of overhead line conductors, joints and insulators, the study of conductor deterioration, with particular reference to the effect of polluted and corrosive atmospheres. Other matters of interest include vibration and fatigue on turbine blades and overhead line conductors.

The specialised equipment includes a 12-ton testing machine for measuring the ultimate tensile strength of 10ft length of overhead line conductors and joints. For more general materials testing the laboratory is equipped with a 50-ton universal machine, a 150-ton compression machine, an Izod impact testing machine, and two 2-ton hand-operated machines.

Technical Report

Road Note No. 7: Filling and Sealing Materials for Joints in Concrete Roads. Second edition. H.M. Stationery Office. Price 1s. 6d.—Road Note No. 7 describes the various types of joint which are in use and the different methods of sealing them against the ingress of water, which might soften the subgrade, and of grit, which would cause spalling if trapped between expanding slabs. The properties required in joint filling and sealing compounds are indicated; brief descriptions are given of the materials used. Additions made in this edition are descriptions of machinery now available for cleaning and sealing joints and a section covering the special precautions necessary in dealing with joints in concrete roads on housing estates.

Changing Pattern of Maintenance and Repair of the Machinery of the Fleet

By REAR-ADMIRAL JOHN E. COOKE, R.N., M.I.Mech.E.*

No. I

This paper, of which an abstract is printed here, was presented on July 7th at Southampton, during the Summer Meeting of the Institution of Mechanical Engineers. Its purpose is to show the changes which have taken place in the maintenance and repair of the machinery of Her Majesty's ships during the past forty years, the reasons leading up to the changes, and the trend of the future.

In the paper only main and auxiliary machinery are dealt with. The many other items of equipment such as gun mountings, torpedo tubes, aircraft-carrier flight-deck machinery, &c., for which the engineering departments of ships and dockyards are responsible are not touched upon. Neither are the often inter-related items of hull and electrical equipment dealt with. An attempt to do so would make the subject matter too vast.

Definitions of Maintenance and Repair

It is necessary to define the terms "maintenance" and "repair."

By "maintenance" is meant day-to-day servicing, prevention or reduction of the rate of wear and tear, and rectification of such wear and tear and breakage as does occur which is within the capacity of the ship's staff and the equipment and stores provided on board. In small ships, destroyers and downwards, this also includes the potential of depot ship or base staff, equipment and stores. Its object is to enable a warship to meet its operational commitments at the highest possible efficiency and achieve its highest possible availability between, in peace its planned periods in dockyard hands, and in war its opportunities for receiving dockyard attention.

"Maintenance" can be subdivided into:

(*a*) "Preventive maintenance," in which there is a planned routine of servicing, examination and corrective action before excessive wear or breakdown occurs.

(*b*) "Breakdown maintenance," in which rectification is applied after excessive wear or breakdown occurs.

By "repair" is meant the rectification of wear and tear and damage beyond the capacity of the ship's staff and equipment for which the resources of a dockyard and greater time and manpower are required.

The Period 1945–55

The Aftermath of War.—The end of the 1939–45 war found a vast increase in spare gear used, including complete auxiliaries, a policy of repair by replacement in the small internal-combustion engine field, and a growing consciousness of the need to plan maintenance in detail, and integrate with operations. Many lessons had been learnt, the seeds of which were germinating, some rapidly, some more slowly. Holt and Clemitson (1949) considered that British warships withstood the severe tests of war very well, and that, whilst operational demands severely curtailed opportunities for proper maintenance, there were no abnormal troubles of a general nature. They concluded that maintenance of machinery in an operational condition throughout the years of a long war is a pressing technical difficulty and that design should cater for "minimum need for, and maximum ease of, maintenance."

In the Fleet, as mentioned earlier, there was a heavy back-log of dockyard repair work and much outstanding maintenance, whilst complements were being reduced by demobilisation and the standard of skill had been subjected to the natural fall inherent in a long, hard war. Examinations were long overdue, so that preventive maintenance had taken a back place and much effort was expended on breakdown maintenance. Because of the amount of dockyard repair work, refits were rationed to give each ship a fair proportion of the effort available.

For all classes except smaller vessels, the length of refit in relation to the interval between has been increased compared with that obtaining prior to the war, yet even so, and despite fre-

* Engineer Manager at Portsmouth Dockyard.

quent extensions, it was not enough to cater for the back-log of repair work and the ever increasing complexity and additions to equipment of ships, so that rationing of dockyard effort had a further unavoidable adverse effect on bringing ships up to a standard such that preventive maintenance could operate. The rectification of this state of affairs was to take some years and is discussed later.

Internal Combustion Engines.—In the internal combustion engine field it had been recognised that the number of types of engine and parts in use must be reduced to a minimum by standardisation, all removable engines must be refitted at specialised overhaul establishments, and spare parts must be readily provided the world over in sufficient numbers and in a fit state for use. The engines in use at the end of the war were divided into two categories ; in one, the smallest possible number of types which would continue in service until Admiralty Standard Range engines covering all powers from 6 b.h.p. to 2000 b.h.p. could be brought into service, and in the other, the engines which would be allowed to die out. The Admiralty Standard Range One engine, covering 500–2000 b.h.p., by variation of number of cylinders and degree of supercharging, was developed at the Admiralty Engineering Laboratory, West Drayton, and Chatham Dockyard and put into production at Chatham. Manufacture to close tolerances for interchangeability of parts was mandatory, and resulted in Chatham Dockyard developing and becoming equipped with a full dimensional inspection system, the only dockyard to be so equipped as yet. The requirement for lower-powered standard-range engines which will, in the main, replace those still in service and not in the standard range one is being met from commercial designs on the same principle.

To achieve satisfactory overhaul and restoration to the same "life" as is to be obtained from new engines, satellite internal combustion engine overhaul establishments have been set up outside each home dockyard. To each has been allotted the task of complete overhaul of three or four different types of engine on the batch-line principle. Here engines are cleaned, stripped, gauged, rebuilt, tested, preserved and packed. Engine parts may lose their identity. New or reclaimed parts are used to replace those found worn beyond the acceptable limits. Electrical equipment is repaired or renewed. Reclamation of parts is not yet practised at those establishments, except for fuel pumps and injectors which are reclaimed at the Portsmouth satellite establishment. This is a departure from previous dockyard repair practice and heralds further change for advanced steam auxiliaries. There is also a complementary change of policy in maintenance of the engines in the craft and boats in which they are fitted. Preventive maintenance schedules have been prepared and are in force for each type of engine. All servicing and maintenance up to top overhauls is carried out in place by ship's staff. When major overhaul becomes due or any defect develops which is of a nature beyond the maintenance routine, the engine is changed by obtaining a fully tested, overhauled engine from the appropriate overhaul establishment and returning the defective or overhaul-due engine. For ships abroad, engines are obtained from, and returned to, the nearest spare parts distributing centre. Internal combustion engine overhaul shops have also been established in the dockyards abroad, but these have to be capable of dealing with all types of engine on the station and are, therefore, still jobbing shops and situated in the yards.

Spare Parts Distributing Centres.—The 1939–45 war had taught that a fully organised spare gear organisation of all types of spare gear, hull, electrical, and engineering, was a permanent necessity and, in 1946, this was established temporarily at Hampstead Norris, near Newbury (because of the early need to vacate the many requisitioned premises which had been used for spare gear of all kinds during the war) and, finally, in 1949 at Eaglescliffe, County Durham. This is known as the Spare Parts Distributing Centre (U.K.). As remarked earlier, Spare Parts Distributing Centres (S.P.D.C.s) had been set up at Malta and Ceylon in 1943. When the war ended similar establishments were initiated in Singapore and Hong Kong. These are all now fed from the parent establishment at Eaglescliffe and form part of the chain for ready supply of any required part, sub-assembly, or assembly in any part of the world. Because of the large stocks of spares which had been built up for internal combustion engines, these were the first to be offered a complete service for engines in common use, but even in this field the task and cost were formidable. Quite apart from moving vast quantities of all sorts of spare parts from many centres and getting them into order, and binned or racked, usage factors and stock to be held had to be determined, and Parts and Allowance Lists with adequate "exploded" drawings had to be prepared and issued to ships, to enable demands to be accurately made. This work still goes on, considerable steam and electrical machinery is now covered and development continues. One of the tools of effective maintenance has been forged. It does not as yet cover everything. There are still in service many machines whose numbers of one type are small, or are soon to pass out of service, for which the cost of provisioning is not justified. The supply of parts for these must still be as before, and frequently entails dockyard manufacture.

There is one further aspect of spare gear supply. During the war considerable quantities of badly wanted spare parts were received unfit for use or unidentifiable because, whilst in transit or storage in tropics, corrosion or damage had occurred. To overcome this and the many other causes of deterioration to which stores of all sorts are subjected, a standard inter-Service specification for Preservation, Identification and Packaging (P.I.P.) has been framed and brought into use, and orders placed with manufacturers include compliance with this specification. All parts subject to corrosion are cleaned, preserved and covered with a strippable plastic coating so that they are entirely sealed, whilst identification is so arranged that the preservative is not damaged in determining the exact contents of the package and the identification is not lost. Plant for carrying out this work has been installed in the dockyards.

Naval Servicing Craft Bases.—The 1939–45 war experience with naval servicing craft, those essential maids-of-all-work, showed the need for organised maintenance bases of a permanent nature at the major naval ports. On the outbreak of war, the dockyards were fully occupied with bringing forward warships, conversions of merchant ships required for Fleet duties, and many other demands which gradually merged into a rising crescendo of repair work. The small locally operated naval servicing craft, without which the activities of the port would be brought to a standstill, got but scant attention in this pressure of work directed naturally to seagoing vessels, and at a time when dockyard slips and docks were at a premium. The Admiralty therefore directed that central naval servicing craft bases were to be set up under the supervision of the Commanders-in-Chief at each Home Port. These bases, manned by the Navy, are quite distinct from the dockyards, relieve the dockyard of much small and uneconomical work in peacetime, enable economies to be effected by pooling small craft in an area and, above all, ensure an adequate maintenance organisation for an important service in time of war.

Post-War Advances Aiding Maintenance and Repair.—In the Fleet, in the years since the end of the 1939–45 war advances in equipment and practices, some born and applied under the goad of war experience, and others in the respite of peace, have been developed and generally applied. Amongst these are improvements in habitability in machinery spaces such as the application of plastic lagging of adequate thickness to all heat-emitting surfaces, fitting gland vapour suppression systems, changes in ventilation systems based on instrumentated examination and critical analysis of results in a typical ship of each class, the use of water washing for external boiler cleaning, the provision of oil-fuel tank and bilge-cleaning vessels, the use of sodium nitrite as a corrosion inhibitor in lubricating oil systems where contamination with sea-water occurs, and the introduction of Admiralty evaporator compound which enables evaporators to maintain their output for much longer periods before cleaning is necessary and, when this has to be done, makes it a much easier task. All these, although having other merits, either lessen the work of maintenance, or increase the effectiveness of the limited labour force upon which maintenance depends.

Methods and Techniques

In the dockyards and attached laboratories new processes and techniques have been developed and applied. These include :

"Clean" Shops.—"Clean" shops have been constructed for hydraulic and instrument work in which all incoming air is filtered and cleaned, and the air in the shop is maintained at a slightly higher pressure than that outside, so that dust and dirt cannot enter. These shops are fitted with air locks for entry and exit, vacuum systems are installed for cleaning, and personnel cleanliness is encouraged by the provision of changing and washing rooms and the use of white overalls. This technique may well form the pattern for future close tolerance work of other natures.

Chemical Descaling.—Chemical descaling of heat exchangers on the sea-water side by circulating through the tubes a diluted proprietary cleaning agent consisting of hydrochloric acid, phosphoric acid, and a suitable inhibitor has been developed for safe and satisfactory use in main and auxiliary condensers and drain coolers. Any ferrous parts in a system are first protected with a rubber-based paint and arrangements are made to ensure that the acid cleaning agent is contained entirely in the sea-water side of the heat exchanger. After circulation for about four hours, the acid is left to stand in the system overnight and recirculated the following day until gassing ceases. It is then removed and the system flushed through with fresh water. The results have been most satisfactory, there have been no cases of tube plate or tube attack, and, in the case of badly scaled main condensers, vacuum has been restored to the design figure. The saving in time, labour and cost compared with detubing, descaling in an acid bath or replacement of the tubes by new ones, followed by retubing, is vast. Another tool of maintenance has been forged.

Electrolytic Derusting.—Electrolytic derusting has been further developed by members of the Royal Naval Scientific Service, working at the Central Metallurgical Laboratory attached to Portsmouth Dockyard and in the dockyard, in particular in its application to machinery parts *in situ* such as the interior of turbines. This process, originally developed by Colonel Cox, of the United States Transportation Corps for derusting cargo tanks by passing a low-voltage, high-amperage current through an electrolyte of common sea-water with the article to be cleaned arranged as the cathode in the circuit, was first used at Portsmouth to derust successfully the interior of a high-pressure turbine in H.M.S. "Indomitable," using a generator in the ship supplying 300A at about 12V, and a dilute solution of caustic soda as the electrolyte which does not attack parts subject to sea-water attack such as stainless steel blading. The process is now in use in the factory in Portsmouth Dockyard for cleaning turbo-generator turbine rotors and casings, and at the time of writing is being used for cleaning the low-pressure turbine of H.M.S. "Armada," using in this case a further development in the electrolyte to obtain easier separation of rust deposit from that most difficult position—between the blades. The action depends upon hydrogen gas being generated at the cathode by decomposition of the electrolyte by the current. The hydrogen so produced has a reducing, scouring and lifting effect on the rust as the action takes place at the interface of the rust film and the parent metal. Another successful example of the use of this process in the maintenance of ships is the removal of rust from decks, prior to preservation for reserve, by applying iron-mesh electrodes contained in canvas bags filled with sea-water and passing a current between the deck and the anode electrode. There are other uses in the maintenance field.

(To be continued)

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THE " MECHANICALS " AT SOUTHAMPTON

Some of the members of the Institution of Mechanical Engineers, which held its Summer Meeting at Southampton last week, may have felt surprise upon making their first visit to the town to find that it was once ringed with mediæval walls, of which indeed much still remains, including several gateways. Surprise is engendered because in the public mind Southampton is so closely linked with great liners, particularly those plying across the Atlantic to the United States and Canada, and southwards to South Africa. It is natural to suppose that the town must have grown to importance only within the 19th and 20th centuries ; and, indeed, in a sense the impression is true enough. For from the days of the first Elizabeth right up to the Victorian era the fortunes of Southampton ebbed. Recovery coincided with the growth of trade and more particularly of passenger traffic across and up and down the Atlantic ; and it was much encouraged by the port's famous double tides and small tidal movement both of which favour its use by the great ocean liners of the present day like the " Queen Mary " and the " Queen Elizabeth." So it is apt to be forgotten that Southampton was important in Roman times ; that it was a flourishing town at the time of the Norman Conquest and for long centuries thereafter ; and that it was the sally-port of England through which the armies that fought at Crecy, Poitiers and Agincourt passed. The very gate through which those armies marched down to the quays where they embarked still stands to this day. Through that gate, too, at a later date passed the Pilgrim Fathers on their way to America. Only an accident of the sea—so claims Southampton—made them put into Plymouth to refit before finally leaving England's shores.

But even in its days of decline Southampton still retained, as it retains to this day, its connection wtih the Navy. Three of its sons who were active at the end of the 18th century were honoured by the President when he unveiled during the meeting a plaque newly offered to the Westgate. It commemorates the Taylors of Southampton who equipped Nelson's fleet with the very large numbers of blocks needed for the making of his ships—a 74 gunner needed no less than 1400 blocks of various sizes—and developed accurate and speedy means of manufacture akin to mass-production. To quote from the plaque " They were probably the first manufacturers to guarantee workmanship and materials and were important pioneers in the machine tool industry." Very appropriately one of the papers presented at the meeting dealt with their work. This abiding connection of Southampton with the Navy and the sea led to the meeting becoming predominantly a Naval and marine occasion, aeronautics running a close second to the sea. Indeed the highlight of the meeting was provided by the Royal Naval Air Station at Lee-on-Solent where the members were privileged to see Naval pilots giving a remarkable display of flying in aircraft as various as helicopters, gliders, and fast modern fighters. Unfortunately, owing to the continuing effect of the recent seamen's strike a visit to the " Queen Mary " had to be cancelled ; but the "Queen Elizabeth" docked late on the night of the members' arrival ; and at another quay there was to be seen the " Southern Cross " passenger liner with engines astern which only entered service a few months ago. In relation to the whole membership of the Institution the numbers attending the meeting were small. Some 261 members and rather more than half as many ladies came to Southampton. But the comparison is misleading. Those who attend the Institution's summer meetings in this country are, rather naturally, predominanatly drawn from places reasonably close to the town or city chosen for the meeting. On the present occasion, for example, there was only a sprinkling of members from the North. A truer impression of the part played by summer meetings in Institution affairs could only be gained by assessing how many members have at some time attended one. Such a figure could convey quite a different impression. The meeting at Southampton was a great success and would have been one even if it had not been favoured by a spell of remarkably fine weather.

This year's summer meeting is now over ; and those members who make a point each year of attending the Institution's summer meetings will already be looking forward, wondering where the next will be held. Not even the Council yet knows. Excitingly, since the Institution held so succeessful a meeting in Holland last year, it may well be that it will decide to venture abroad again. Western Germany suggests itself as a possibility because its engineering works have now fully recovered from the war and because its products compete with this country's in many of the markets of the world. It may be, however, that the Council will choose not to adopt the practice of the Iron and Steel Institute which, more or less regularly, holds its summer meetings in Britain and abroad in alternate years ; that it may feel that such a practice would give too much prominence to the work of other nations. If so, however, we would suggest that the Institution should endeavour to hold summer meetings abroad at regular, rather than irregular intervals, so that its members can look confidently ahead, and if need be make financial and other preparations in advance.

PLANS FOR MOTOR ROADS

Last week, there was a debate in the House of Commons on the occasion of the second reading of the Road Traffic Bill. The Bill is intended to provide a code of law governing conduct on the road, and suggests various measures, such as the introduction of parking meters. The Opposition opposed the Bill because it did " not provide a comprehensive policy to deal with the urgent and increasing problems of road traffic and road safety." In replying to the debate, the Minister of Transport and Civil Aviation, Mr. Boyd-Carpenter, said that it was a fallacy to imply that the Government's road policy should all be embodied in the Bill, which was intended to alter the law to comply with the needs of that policy. Mr. Boyd-Carpenter then went on to outline the " major road programme " of which the Government was in the early stages. On the following day he gave further information on the Government's programme of new road construction at a Press conference. Thus the effect of last week's events has been to draw attention once again to the need for new roads, which is now generally acknowledged to lie at the root of the problem, and rather to overlook the Bill debated in the House. The information given by Mr. Boyd-Carpenter at his Press conference was by way of amplifying the statement he made early this year, which was printed in THE ENGINEER of February 11th last. It may be recalled that the Government's programme was explained in some detail at that time, but no figures of

year-by-year expenditure were given. It was stated that schemes ultimately costing the Exchequer £27,000,000 would be authorised in 1955–56, and schemes totalling about £120 million of Government expenditure would be authorised in the subsequent three-year period.

In these first-stage proposals, to be authorised by 1958–59, one motorway route is included, namely, the first stage of the London–Yorkshire motorway, extending from the northern end of the proposed St. Albans by-pass to Dunchurch, near Birmingham. On this 53-mile length of motorway it is planned that there will be six fly-over junctions, at four of which slip roads will connect the motorway with a roundabout, built over or under it, at the level of the existing road. The motorway will have dual three-lane carriageways and a formation width of 112ft ; the two 36ft carriageways will be separated by a central reservation 15ft across, and there will be a 12ft 6in strip outside each carriageway incorporating a hard shoulder 8ft in width, with 1ft marginal strips on each side of each carriageway. The design speed of the motorway will be 70 m.p.h., and its estimated traffic capacity is 30,000 vehicles daily. Although this first British motorway will be completed many years behind its counterparts in other countries, it appears that its design and construction will set a very high standard. Economically, it should show itself to be one of the country's most profitable capital investments of recent years, but this prediction remains to be confirmed as experience of its use is gained. For although the construction cost has been given as approximately £250,000 per mile, the Ministry has been chary of giving a prediction for the volume of traffic which will use it, the route being an entirely new one. We learned at the conference that it is planned to publish the route of the new motorway in the autumn ; then three months must elapse for objections and possibly a public inquiry. It is thought that actual construction will probably start in about two years and the project will be completed in about four years from now. The second section of the London–Yorkshire route, totalling 107 miles, will then be started, but it is planned to start a 94-mile length of motorway from a point north of Birmingham to the Preston by-pass, while the first section is still under construction. Work to be authorised in the 1956–59 period also includes seven by-pass roads, totalling 84 miles in length, for use as general-purpose roads initially, but built to motor road standards for eventual incorporation in through routes. The Minister thought that the schemes authorised in this period would have progressed " a good way " five years from now and he was confident they would be completed in less than ten years.

So we can expect to be able to drive along the first British motor road in about four years' time. By then, it is expected that there will be 9,000,000 motor vehicles on the roads. There are 6,250,000 now, and there were 3,100,000 in 1946. Accidents have not increased in proportion with the increasing traffic (the researches and suggestions of the Road Research Laboratory have helped significantly here), and they may not increase very much further, as more attention is given to satisfactory legislation, vehicle maintenance and so on ; but there is little hope of a reduction unless the road programme is " expanded " once again with some vigour. With the various by-passes and other improvements which should be well under way by the time that the London–Birmingham route is completed, it would seem that cross-country travel will by then have improved, here and there, in spite of the increase in traffic. However, the proposals in the Government's plan offer little prospect of improvement in the circulation of traffic in large cities. The works proposed in this category are of a local nature—a new tunnel, a reconstructed bridge, or a length of road to be widened. Nowhere is there a comprehensive plan—even of a very long term—to give adequate traffic facilities, serving, for instance, London, or an area in London, or any other of the large cities. The problem is one which needs imaginative planning, bold engineering design, and a sound appraisal of the benefits, economic and humanitarian, to be gained from efficient and safe traffic circulation within a city. It has been too difficult for the official planners to grasp this nettle, and the measures published in the first stage plans will, we think, fail to prevent increases in the congestion of central city areas, particularly in London, if the predicted increases in vehicles do, in fact, materialise.

HIGH-SPEED TRAIN SERVICES

More than a hundred years ago Isambard Kingdom Brunel said : " I shall not attempt to argue with those who consider any increase in speed unnecessary. The public will always prefer that conveyance which is the most perfect ; and speed, within reasonable limits, is a material ingredient in perfection of travelling." A few weeks ago, we were stirred by news of a maximum speed of more than 200 m.p.h. by an electric train on the French Railways, and the thought has naturally arisen as to whether such a speed might be possible here. There is, however, a world of difference between an isolated, if superlative, run of this character and the maintenance of a fast service on lines as crowded as those of this country, and we publish elsewhere in this issue an account of the personal travelling experiences of Mr. O. S. Nock during the first six months of the high-speed train services introduced on the Western Region last summer. There is a great deal more to it than a mere ability of the locomotives to run fast. Our contributor's analysis of more than fifty journeys on trains booked at speeds of 60 m.p.h. or more, brings out a number of points that must obviously be borne seriously in mind during the transition period before full electrification of the railways comes to pass. The mastery of the locomotives over the tasks set to them on the fast trains was well-nigh absolute ; against an aggregate of 200 min gained on booked time there was to be set a loss of no more than 14 min, and all of this latter could be attributed to extenuating circumstances rather than failure of the machine itself. This is not to say, however, that some of the delays experienced could not be booked against locomotives as such. On two occasions serious delay arose due to failures of engines on other trains, with consequent hold-up of traffic, and it is indeed the causes of delay rather than the competence of the locomotives allocated to the crack trains that makes the most interesting and, at the same time, disquieting reading.

Out of fifty-three runs observed in detail, the plain fact stands out that on only twenty-four was the arrival on time. It is true that during the period of analysis a certain amount of permanent way work was in progress. But allowance has been made for this by the insertion of " recovery time " into the train schedules, and on only one occasion, when exceptional weather had caused a minor landslip and had added a third heavy reduction of speed to two others that formed part of the ordinary programme of track renewal, was the work of the locomotives inadequate to cover the loss of time due to engineering slacks. Neglecting twelve journeys on which the arrival was 5 min late or less, we may be concerned more seriously with seventeen out of the total of fifty-three, which were more than 5 min late. Of these late arrivals, four were due to climatic conditions, including fog and, on one occasion, a heavy gale. They can be regarded as more or less unavoidable, and in much the same light as a whole string of delays arising from a minor derailment on another line, which for a short time led to considerable dislocation of traffic. The avoidable delays arose from engine failures on other trains, and from that now perennial bugbear, signal checks. That there has been a general deterioration in engine maintenance since the outbreak of war in 1939 is common knowledge ; the incidence of blocked tubes and rough riding tell their own tale, while even on locomotives allocated to the hardest duties the spectacle of leaky and blowing glands is significant of the trend of affairs to-day. Even in such circumstances, however, a steam locomotive will still run and keep time. When the diesels are with us the situation will change. Railway motive power staffs may then well read the word " maintenance " in letters of fire ! Experience since the restoration of certain high-speed services should certainly be a warning for the future.

Difficult though this problem is, however, engine maintenance is capable of being tackled in a straightforward manner. The problem of traffic regulation is infinitely more complex. Our contributor's analysis includes cases where the running of a relief train to cope with heavy traffic upset timekeeping to an appreciable extent. One might argue that the lines are already crowded with trains, but it is rather ironical that when there are more customers about the service should deteriorate ! Our correspondent also draws attention to a case where the timetable itself provides so slight a margin between trains that delays are almost inevitable. The matter of improving regulation is one to which engineers can make a notable contribution, by the concentration of signalling control ; but the eventual solution is not to be found by different forms of motive power or by the installation of colour-light signals. Recent experiences on the Manchester–Sheffield electrified line, with express passenger trains, show that despite all that engineers have achieved operating arrangements are at times so faulty that even with the C_0+C_0 locomotives and loads of

no more than 200 tons booked times could not be maintained because of the signal checks experienced *en route*. We have hammered this point before, and we shall no doubt have to do it again ; if British Railways is to be the efficient organisation that the British Transport Commission has promised us a new attitude towards operating urgently needs infusing into the staffs concerned.

Obituary

GUSTAVE MAGNEL

WE regret to record the death, on July 5th, of Professor Gustave Magnel, the well-known authority on prestressed concrete. Professor Magnel was director of the reinforced concrete laboratory at Ghent University, and was well known in this country for his book on prestressed concrete, for his numerous lectures and addresses delivered here on that subject, and for his development work on prestressing, which led to his association with the Magnel-Blaton system of prestressed concrete. This system has been applied in the United Kingdom by Stressed Concrete Design, Ltd., a firm of which he was a director. Professor Magnel was particularly interested in all aspects of the phenomenon of " prestressing," and he carried out tests on prestressed steel structures, as well as his better-known works on prestressed concrete. He had numerous publications to his credit, principally on prestressed concrete, in this country, in the United States and in Belgium. He graduated at Ghent University in 1912, and then was employed by the firm of D. G. Somerville and Co., Ltd., of London, until 1917. Then he started his long and distinguished career at Ghent University. Professor Magnel was a member of the Institution of Civil Engineers and of the Institution of Structural Engineers. His death will be regretted by many engineers in this country, who associate his name with the development of the " Belgian " system of prestressing, and of its many achievements in practice, such as the Sclayn bridge across the Meuse and the Melsbroek hangars near Brussels.

J. J. CONLAN

MR. J. J. CONLAN'S many friends in the electrical industry will learn with regret of his sudden death at his home on Wednesday, July 6th, after nearly forty years of service to the British Electrical and Allied Manufacturers' Association.

Mr. Conlan was born in Dublin in 1892 and when he was twenty-three he joined the Beama as assistant to the director, Mr. D. N. Dunlop, who was editor of *The Beama Journal*. Then, after a period of war service, he rejoined the Association's staff in 1918. He took a prominent part in many Beama activities, including the electrical section of the Wembley exhibition and the formation of the World Power Conference in 1924. When Mr. Dunlop died in 1935, Mr. Conlan succeeded him as editor of *The Beama Journal*. From 1945 to 1953 he was secretary of the Beama publicity committee, and since then he has served as a member of the committee. He was also head of the publicity and statistical department of the Association. As such he was responsible for many of the books published by the Association, including his study of the life and work of Michael Faraday, and the *Beama Catalogue*.

Literature

Electric Power Transmission. By J. ZABORSZKY and J. W. RITTENHOUSE. London : Thames and Hudson, Ltd., 244, High Holborn, W.C.1. Price 70s.

THE authors of this book are members of the staff of the School of Mines and Metallurgy, University of Missouri. They have written a very good book. It is distinctive. Its most valuable feature is that it assembles much useful material from recently published papers. It thus contains much up-to-date information, but it also contains an excellent account of the fundamental theory associated with electric transmission.

The authors state " this book is believed to be equally useful as a text for undergraduate or graduate courses in power transmission and as a reference work for the practising engineer." In this country its chief appeal will be to the practising engineer. For the student the book contains excessive detail application of fundamentals. Also, much of the contents taken from recent publications, which makes the book so useful to the practising engineer, is unsuitable for an undergraduate course. A very suitable text for undergraduates could be compiled by a judicious selection from this book. The book has a lengthy introduction (fifty-nine pages), eleven chapters and two appendices. The authors state " this extensive introduction is devoted to a purely qualitative discussion of the basic structure of the power system," and continue, " most students are seriously handicapped in power transmission courses by their lack of knowledge of this basic structure. A careful reading of this introduction should result in much-improved overall results in the teaching of power transmission." Unfortunately, this valuable and well-intentioned introduction is tedious to read and tends to over-elaboration.

Chapter I concerns the inductive reactances of transmission lines. In addition to the normal single and three-phase lines, it considers a single-phase line having any number of conductors in parallel, double lines (single and three-phase) stranded conductors made of materials which are (*a*) the same throughout the conductor, (*b*) different. Chapter 2 deals with conductor resistance and includes a study of skin effects by the usual method employing Bessel functions. In Chapter 3, capacitative reactance of transmission lines is very fully considered. Corona is dealt with in an adequate manner in Chapter 4. Chapter 5, on cables, includes a full mathematical treatment of eddy currents in the shielding of single-phase cables and of the temperature rise of cables in ducts. Chapter 6 deals with " The Transmission Line with Distributed Constants " by the orthodox mathematical treatment. Chapter 7, on " Performance of a Power Transmission line in the Steady State," is excellent. This chapter includes consideration of " stability," the use of shunt capacitors for long lines and a number of performance *loci*. Chapter 8 is essentially concerned with power network analysis, including network transformation formulæ and the inclusion of transformers in the system. Chapters 9 and 10 deal respectively with control of voltage and control of frequency. They are particularly useful chapters dealing, as they do, with important topics which have been neglected in books on power transmission. Chapter 9 discusses the use of reactive power for voltage regulation (synchronous and static condensers), also various applications of regulating transformers. Chapter 10 gives an excellent discussion of governor characteristics and of various automatic devices for maintaining commercially " constant " frequency. The final chapter deals with power system economy. It considers a system with a number of generating stations and discusses the conditions for economic load division. It also deals with the economic expansion and modernisation of existing plant to deal with increase of load. Appendix I gives useful tables of conductor and cable characteristics. Appendix II deals with methods of solving simultaneous linear equations, including tabulating methods, the relaxation method and network analysers.

The book contains numerous well-chosen, worked-out numerical examples and many unworked examples. References to original papers are copious. Production is excellent in all respects except that the photographic reproductions are poor and usually of little educational value. It can be recommended to power system engineers and to lecturers.

Atomic Energy Conference at Geneva

FURTHER details have been published of Great Britain's participation in the international conference on the peaceful uses of atomic energy to be held at Geneva next month (THE ENGINEER, April 1st, page 451). Sixty-seven papers dealing with various aspects of the subject will be presented by members of the British delegation. They will include " The Contribution of Nuclear Power to United Kingdom Energy Requirements up to 1975," by Sir John Cockcroft ; " The Graphite Moderated Gas-Cooled Pile and its Place in Power Production," by Sir Christopher Hinton ; " The Dounreay Fast Reactor Project," by J. W. Kendall and T. M. Fry ; and " Handling Liquid Metals," by S. Bauer. Besides the sixty-seven British papers which will be presented, there will be twenty-three others which will be published in the proceedings of the conference. The U.S.A. will contribute 170 papers and the U.S.S.R. more than seventy.

Two exhibitions will be held in conjunction with the conference. The first exhibition will be in the Palais des Nations and will be purely scientific, being intended mainly for delegates to the conference. Here the U.K. Atomic Energy Authority display, occupying 3000 square feet, will be concerned mainly with nuclear reactors for research and for power generation and with specialised instrumentation developed for work in this field. Models will be shown of one of the Calder Hall reactors ; of the Harwell heavy water reactor E443 (" Dido ") and of the second Harwell heavy water reactor RE775 (" Pluto "), both of which are now under construction. There will be a display of instruments developed in the Authority's research and industrial groups, for reactor control, for special recording work and for dealing with the industry's raw materials.

The second exhibition is intended for the general public as well as delegates and will be held in the Palais des Expositions. There the U.K. Atomic Energy Authority will occupy 7000 square feet with its exhibits, which will be designed to illustrate British achievements in building up a complete atomic energy organisation and the efforts now being made to exploit fully its peaceful uses. The display will include a detailed model, 17ft 2in by 4ft 3in, of Calder Hall power station, and another, 7ft 6in by 6ft 6in, of the breeder reactor experimental power station at Dounreay.

Models and working exhibits will be used to demonstrate recent advances in the uses of radioactive isotopes, of which Great Britain is the largest exporter in the world. Applications of isotopes in research, industry, medicine and agriculture will be illustrated and there will be a display of surveying equipment.

The contribution made by British firms towards atomic development will be represented by two groups of exhibits—one concerned with heavy industry and the other with instruments—occupying a total of 20,000 square feet.

Chadderton "B" Power Station

The Chadderton "B" Power Station which was opened on July 8th has been designed to meet expanding requirements in the Oldham area. At present two 60MW hydrogen-cooled turbo-alternators are in commission, with two more under construction to give a total capacity of 240MW. Steam is supplied at 900 lb per square inch and 900 deg. Fah. by boilers arranged for pulverised fuel firing and four boilers out of a final total of seven are in service. Sewage effluent is used as make-up water to the cooling towers and the fuel consumption at full load is estimated at 15,000 tons of coal per week.

IT was as long ago as 1943 that the Oldham Corporation first commenced forward thinking with regard to the possible increase in the electrical load on the distribution network, in the years ahead. A survey of sites resulted in the Chadderton site of the existing Slacks Valley L. P. station being selected, while the capacity was estimated at 120MW, to be completed in two groups each consisting of two 30MW generators and five boilers. Later discussions with the Central Electricity Board raised the total capacity of the four units to 200MW, but standardisation of unit sizes resulted in the adoption of 60MW units to give the station an ultimate capacity of 240MW. Towards the end of 1947 directives were given for the development of the station, Messrs Kennedy and Donkin being retained as consultants with L. G. Mouchel and Partners, Ltd., as associate consultants for civil engineering.

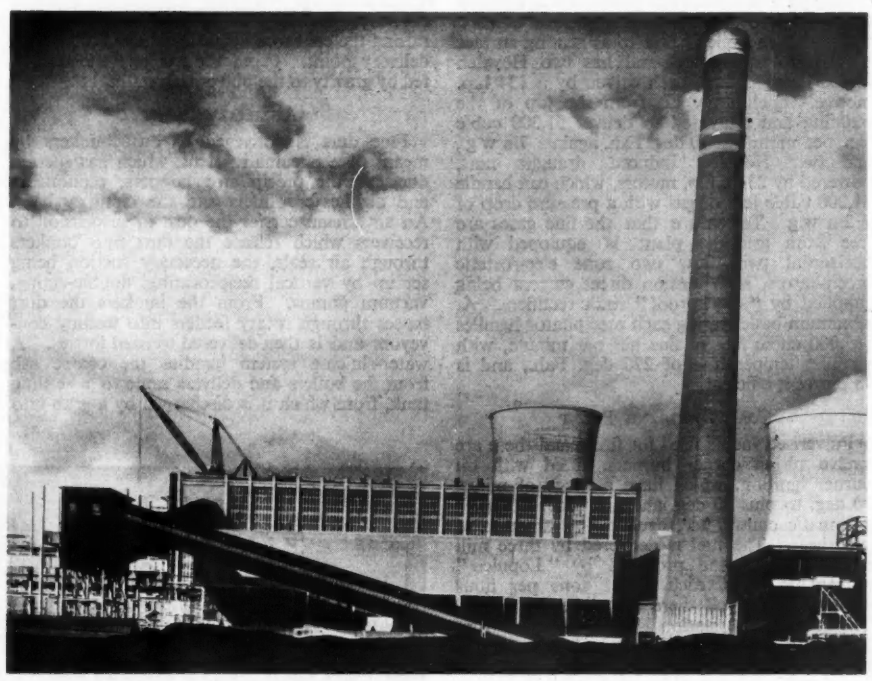
The station was officially opened on Friday, July 8th, by Councillor F. Kenyon, J.P., the chairman of the North-Western Electricity Consultative Council, who unveiled a commemorative plaque. This ceremony was followed by a tour of the station which has two triple expansion turbine-driven 60MW hydrogen cooled alternators in operation with steam supplied by four boilers. Two similar alternators, but driven by two-cylinder close-coupled turbines and three more boilers, all of which are under construction, will complete the project. A general view of the station is given in the photograph reproduced herewith.

Site and Buildings

As already mentioned, the site is the same as that occupied by the existing low-power station and is situated about 4 miles from Oldham. It is bounded on the south side by the Manchester-Rochdale railway and on the north by the Oldham Corporation's sewage works and is intersected by the Rochdale canal while access is by a road leading from a thoroughfare named Broadway. Of the 95 acres part consists of waste land, some of which was used by an aircraft factory some thirty years ago, and approximately one quarter is occupied by the existing station and a 132kV transformer compound. No special reclamation work was required but the ground, which has an average level of 335ft above O.D. with the water level at 332·5ft, was found to consist of top soil above 3ft or 4ft of sandy clay, with pockets of running sand, below which was soft brown clay varying in depth from 6ft to 10ft. To support the various structures several thousands of "Franki" 18in diameter piles were driven at approximately 3ft 6in spacing, 4600 of 40ft average length under the main buildings, 1290 of similar length for the cooling towers and 1167 of about 30ft in length for the ancillary buildings.

All the main buildings have floors of beam and slabs construction spanning between the pile caps. The turbine hall and boiler-house measures 515ft by 320ft and has a riveted structural framework with the main columns at 30ft centres. Reinforced concrete with "Lenscrete" roof glazing and finished with asphalt from the main roof with continuous lantern lights, fitted with louvres, over the turbine house. The external cladding consists of Accrington Golden Brown sand-faced rustic bricks with pre-cast concrete mullions in the main elevations. There is a Granolithic floor finish in the basement and the de-aerator floor, and a cream tile finish on the firing and turbine floors, the latter having a loading of 235 lb per square foot. A pre-stressed concrete bridge of 112ft span connects the administrative building with the turbine house at operating floor level. A Clyde crane having a span of 60ft, a lift of 60ft, a maximum load of 120 tons and an auxiliary hook to lift 15 ton serves the turbine house. The ancillary buildings also have riveted steel framework and brick cladding.

A base slab 52ft square by 6ft thick, carried on piles, supports the chimney, which has a height of 365ft, an inside diameter of 16ft 3in at the top and weighs 8500 tons. A second chimney has to be built and each is associated with a precipitator plant placed at the ends of the main building. Two cooling towers are in operation and a third is under construction. The towers have a height of 310ft with base and rim diameters of 210ft and 137ft respectively, a pond of 224ft diameter and 1,250,000 gallons capacity with a depth of 5ft. They have a maximum capacity of 3,825,000 gallons per hour and a cooling range of 12 deg Fah.. The make up water is sewage effluent from the Oldham Corporation's sewage works turbo-alternator plant and boilers.



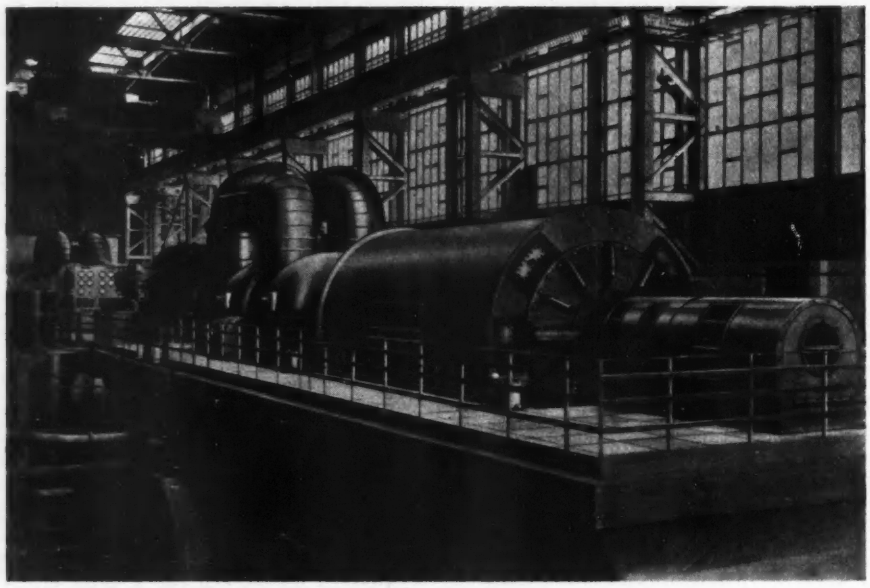
The first half of Chadderton "B" power station as seen from the south-west

Turbo-Alternator Plant and Boilers

As already mentioned the station when complete will have four 60MW turbo sets and those in commission, and illustrated on the next page, are driven at 3000 r.p.m. by triple expansion turbines having impulse blading, the number of stages on the h.p., i.p., and l.p. rotors being eleven, thirteen and ten respectively. The h.p. casings are of ½ per cent molybdenum steel, the i.p. casings of carbon steel with cast iron exhaust end and the l.p. casings of cast iron. Steam is supplied at 900 lb per square inch and 900 deg. Fah. and is exhausted to a two pass multitubular surface condenser operated at a vacuum of 28·7in Hg, and having a cooling surface of 60,000 square feet. Two extraction pumps, rated at 772 gallons per minute against a 223ft head and driven by 105 h.p. electric motors, can each handle the full quantity of condensate. For each set there are two three stage condenser air extractors, of surface intercooling pattern, each of 100 per cent capacity, and also a quick start ejector. The rated vacuum can be raised in ten minutes and the inlet temperature of the condenser circulating water is 65 deg. Fah., the outlet temperature being 76·6 deg. Fah. De Laval turbine lubricating oil purifiers are provided. For each machine there are two l.p. and two h.p. feed water heaters, the bled steam temperatures at No. 1 and No. 2 l.p. heaters being 153 deg. and 215 deg. Fah. respectively and 326 deg. and 392 deg. Fah. respectively at No. 3 and No. 4 h.p. heaters and the final feed water temperature is 380 deg. Fah. There is one twin vertical de-aerator. When complete there will be nine boiler feed pumps, six driven at 3000 r.p.m. by 1380 b.h.p. electric motors and three driven by turbines. All the pumps, of multistage centrifugal design, have a capacity of 1063 gallons per minute against a head of 2907ft and required to deliver 600,000 lb per hour.

The alternators are rated at 60MW and running at 3000 r.p.m. generate current at 11·8kV which will be stepped up to 33kV for short distance distribution and up to 132,000V for supplying the natural grid. Each alternator is hydrogen cooled, and has a direct driven exciter.

Four of the final total of seven boilers, six of which are capable of carrying the full load, are complete and each boiler is of two-drum natural circulation radiant heat design and is supported independently of the main building structure. The maximum continuous rating is 360,000 lb per hour at 950 lb per square inch and 925 deg. Fah. at the boiler stop valve and the economic continuous rating 288,000 lb per hour and at both these ratings the efficiency exceeds 85 per cent. The control panel for No. 1 boiler is illustrated on the next page. The combustion chamber, which gives a heat release of 18,600 B.T.U. per cubic foot per hour at M.C.R., has a capacity of 25,450 cubic feet, is fully water cooled and the water wall tubes have an outside diameter of 3in. A "Melesco" self-draining superheater is fitted and this has three elements connected in series, the primary and secondary each having eighty-eight elements and a heating surface of 6250 square feet and the tertiary, forty-four elements of 2600 square feet heating surface. The economiser is of "Senior" butt welded double banked design and has a heating surface of 23,296 square feet. A Howden Ljungstrom air heater with a



Turbine house showing two 60MW hydrogen-cooled turbo-alternator sets

heating surface of 82,300 square feet is provided and the main dampers are Lockheed hydraulic controlled while Electroflo pneumatic equipment is installed for the automatic control of each boiler. Each boiler has a total heating surface of 143,976 square feet and has two Howden forced draught fans, each driven by a 134 h.p. motive, which draw air from the top of the building and are rated to deliver 51,300 cubic feet per minute at 70 deg. Fah. against 7in w.g., and two Howden induced draught fans, powered by 231 b.h.p. motors, which can handle 81,200 cubic feet of gas with a pressure drop of 7·2in w.g. To ensure that the flue gases are free from grit the plant is equipped with horizontal twin flow two zone electrostatic precipitators, high tension direct current being supplied by "shockproof" static rectifiers. At maximum boiler rating each precipitator handles 163,000 cubic feet of flue gas per minute, with an inlet temperature of 270 deg. Fah., and is 98 per cent efficient.

Coal Handling Plant

Pulverised fuel is used for firing and there are twelve tilting corner burners, fitted with oil burner ignition, which have a range of minus 30 deg. to plus 30 deg. and are under "Kent" automatic control to regulate the amount of superheat. The fuel is delivered by three mill exhauster fans and provided by "Lopulco" pulverising mills, each of 11 tons per hour capacity, of which there are three per boiler. The fuel for the station is mainly drawn from Yorkshire and East Midlands coal fields supplemented by some open cast coal and is of low grade quality namely about 9000 B.Th.U. and an ash content of 18 per cent. At present the consumption is approximately 8000 to 9000 tons per week but this will rise ultimately to 15,000 tons per week. Delivery of fuel is by road and rail and for handling the rail borne coal there are two side discharge tipplers, each of which can deal with wagons up to 35 tons at the rate of twenty per hour. Capstans having a pull of $\frac{1}{2}$ ton at 350ft per minute handle the wagons into the tipplers which discharge into a common hopper, the wagons being weighed both before and after discharge. From the intake hopper two conveyor lines transfer the coal to a hopper, in the screening and crushing house, to which road borne coal is also delivered by a gravity bucket conveyor system from a receiving hopper. After being screened and crushed the coal is directed to the boiler bunkers or to the coal store, which is a semicircle of 500ft radius and has a capacity of 70,000 tons or more according to height of dump. For stacking and reclamation there is a drag scraper.

Twin conveyors, each of 250 tons per hour capacity, transfer the crushed and screened coal via tramp iron extractors and automatic belt weighers to the coal bunkers, in the boiler-house, which are of steel, "Gunite" lined, and of 540 tons capacity. Delivery to the coal bunkers entails raising the coal to a height of about 110ft above delivery point. From the bunkers the coal is fed by gravity to the pulverising mills.

Auxiliary Plant

Flue dust is conveyed to dust bunkers by means of a pneumatic plant, which has suction ducts at the precipitator hoppers, economiser and air heater outlets and the chimney base. An air stream carries the dust in suspension to receivers which release the dust into bunkers through air seals, the necessary suction being set up by vertical reciprocating, double-acting, vacuum pumps. From the bunkers the dust passes through rotary feeders into wetting conveyors and is then delivered to road lorries. A water-sluicing system handles the coarse ash from the boilers and delivers same to a settling tank, from which it is discharged by a grab into lorries. All the ash and dust is transferred to a dumping ground, a few miles distant, which is estimated to have a capacity equivalent to about nine years of station operation.

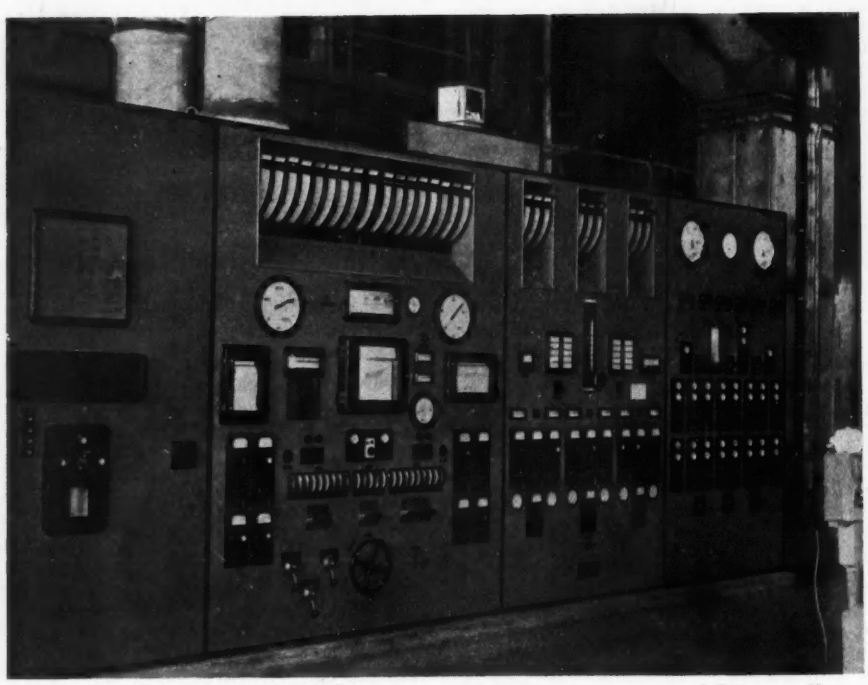
Through each turbo-alternator set two pumps circulate cooling water at the rate of 50,000 gallons per minute; for handling make-up water the station will eventually have six 1200 gallons per minute pumps. Associated with the circulating water system are two master vacuum solution feed chlorinators, one of which acts as standby, with a capacity of 6000 lb of chlorine per twenty-four hours. The units inject the solution on the suction side of the circulatory water pumps and have automatic intermittent action governed by an electric programme clock. For the storage of town's water four 13,100-gallon tanks, of welded plate construction, are installed on a flat arranged at 106ft above basement level. The water-treatment plant consists of three sand filter and base-exchange units, one being a standby, each having a capacity of 7500 gallons per hour. Suspended material in the raw water is removed by pressure filters and there is provision for alum to be added to assist filtration under conditions of draught. After filtration, the water is pumped to, and is softened in, sodium base exchange units.

There is a fully equipped workshop and the 33kV switch houses are fitted with CO_2 fire-fighting equipment, while the main and auxiliary transformers have an emulsion system.

Generators and Switchgear

The alternators, two of which are in commission and two under construction, are each rated at 75MVA, at 11·8kV, three-phase, 50 c/s, and are hydrogen cooled. At a pressure of $\frac{1}{2}$ lb per square inch gauge the hydrogen, acting as a cooling medium, is forced through the stator ventilation ducts by propeller fans mounted on the ends of the rotor, while ventilation of the field winding is through an interconnected system of axial slots in the rotor body. After passing through stator and rotor the hydrogen is directed over the water-circulated cooler tubes and then recirculated. The stator frames are of welded steel plate with four gas coolers longitudinally arranged between the stator outer casing and the core. The winding of the stator is of involute pattern, while the rotor winding is of silicon-bearing copper strap wound on edge.

Excitation is from a direct-connected exciter supplied from a pilot exciter having its armature overhung from the main exciter shaft. All the



Control panel for boiler No. 1 at Chadderton "B" power station

exciters and generator sliprings are contained in a separate housing.

No. 1 and No. 2 generators are connected via 11·8/33kV, 72MVA transformers, located outside the turbine house annexe, to 33kV busbars connected to the 132kV system through two 33/132kV, 60MVA transformers, and to the local 6·6kV distribution system in the Chadderton "A" station through two 33/6·6kV, 30MVA transformers. The generators under construction, Nos. 3 and 4, will be connected directly to the 132kV system through two 11·8/132kV, 72MVA transformers. All the transformers are fitted with on-load tap-changing gear.

The 33kV switchgear consists of two duplicate busbar switchboards, of 1500MVA rating and housed in separate switch rooms, which control the two generators and associated transformers, two grid transformers, two station transformers and two inter-bus transformers which connect to the low-power station. The 33kV switchgear is of oil-immersed, vertical isolation, metalclad pattern, while the 132kV gear is of outdoor bulk oil design and will be placed in the 132kV grid compound.

Supplies for auxiliaries are drawn from 11·8/3·3kV, 6MVA transformers with off-circuit tappings and directly connected to the alternators. Some of the larger auxiliaries are supplied direct from the 3·3kV switchboard, while others are fed from 3·3kV/415V transformers. There are two 33/3·3kV, 10MVA station transformers with on-load tap-changing gear to give starting, emergency and general service supplies from the local system, and also seven 750kVA and four 1250kVA auxiliary transformers. The 3·3kV and 415V auxiliary switchgear is of air-break design and is located in annexes adjoining the turbine and boiler-houses.

The control room is housed in the administrative block and separate rooms have been provided for the control panels and for panels mounting the station protective relays.

PRINCIPAL CONTRACTORS

Mechanical and Electrical Plant.—Simon-Carves, Ltd. (boilers), Metropolitan-Vickers Electrical Company, Ltd. (turbo-alternators, associated plant and station transformers), Wallace and Tiernan, Ltd. (grit settlement plant and chlorination equipment), Stewart and Lloyds, Ltd. (high and low-pressure piping), Mather and Platt, Ltd. (pumps), Ferguson Pailin, Ltd. (main switchgear), English Electric Company, Ltd. (auxiliary switchgear), International Combustion, Ltd. (boiler burners and pulverised fuel mills), Brightside Foundry and Engineering Company, Ltd. (C.W. pipework), Wharton Crane and Hoist Company, Ltd., Clyde Crane and Engineering Company, Ltd., and Herbert Morris, Ltd. (cranes) Electroflo Meters, Ltd. (boiler control equipment), J. Blakeborough and Sons, Ltd. (l.p. valves), Hopkinsons, Ltd. (h.p. valves, soot blowers and T.V. water level indicator), Andrew Barclay, Sons and Co., Ltd. (locomotives), Bonar Long and Co., Ltd. (auxiliary transformers), Enfield Cables, Ltd. (cables), Brookhirst Switchgear, Ltd., Contactor Switchgear, Ltd. (group starter boards), Norris Warming Company, Ltd. (heating and ventilation), Mather and Platt, Ltd., Walter Kidde Company, Ltd. (fire-fighting equipment).

Civil Engineering.—M. J. Gleeson (Contractors), Ltd. (site clearance, foundations), Franki Compressed Pile Company, Ltd. (piling), Edward Wood and Co., Ltd. (steelwork, main and administrative buildings), Simon-Carves, Ltd. (foundations for precipitators and coal-handling plant, structural steelwork for ash and dust plant, and coal-handling plant), F. Mitchell and Sons, Ltd. (superstructure ash and dust plant, cooling towers), P. C. Richardson and Co., Ltd. (chimney superstructure), T. W. Ward and Co., Ltd. (railway sidings).

Short Notice

Four-Cutter Practice. By A. H. Haycock. London: Technical Press, Ltd., 1, Justice Walk, Lawrence Street, S.W.3. Price 16s.—This is the fifth and final volume in the author's series of books on the principles of machine woodworking, and is so far as we are aware the only book dealing exclusively with that most important piece of equipment, the four-cutter. Apprentice woodworking machinists, for whom the book is primarily intended, like those in other trades, have to learn much by actual experience. But a book such as this dealing in a clear practical way with a particular machine provides a valuable source of reference and means of supplementing experience gained in the shop. The various sections are well illustrated and deal in detail with the design, construction and operation of the four-cutter, cutter design, setting, sharpening, &c.; moulding in multiple; balancing and chip extraction.

Mining Pump with 350ft Head

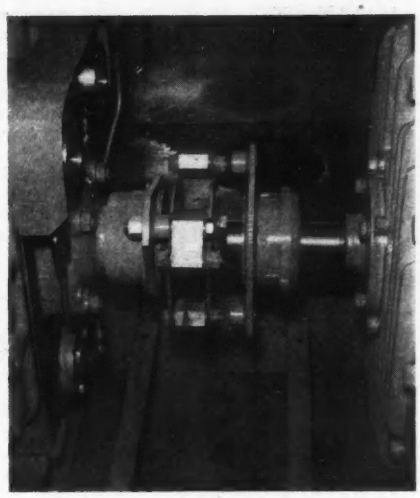
EXPERIENCE gained from the manufacture and operation of large numbers of pumps has been embodied in the design and construction of the new mark G.H.4 mining pump which Megator Pumps and Compressors, Ltd., has put recently into quantity production following the successful conclusion of a long trial period in a number of mines. All Megator pumps stem from the earlier triple ram model and continue to possess the same distinctive characteristics of the first pumps, such as simple and robust construction, high suction lift, self priming, almost constant capacity over the range of suction lift and delivery head and easy maintenance.

The new pump is of considerably increased capacity and capable of operating at increased heads. The pump, a prototype of which we inspected while undergoing tests at the experimental station of the company at Edgware, is intended for intermediate pumping in mines and is well adapted for pumping between levels in horizon mining or to the surface from the working face in shallow mines. There are several new mechanical devices of interest and the pump, which is normally direct coupled to a 30 h.p. electric motor, is driven at 960 r.p.m. to deliver 160 Imperial gallons per minute against a total head of 350ft. Our first illustration shows a standard mining unit which is mounted on a steel skid base, the whole being easy to handle and requiring only low headroom, the approximate overall dimensions being length 7ft, width 2ft 8in, and height 2ft 9in. However, other forms of mounting and drive are available as required, and as an alternative a 20 h.p. motor can be used to give a total head of 200ft.

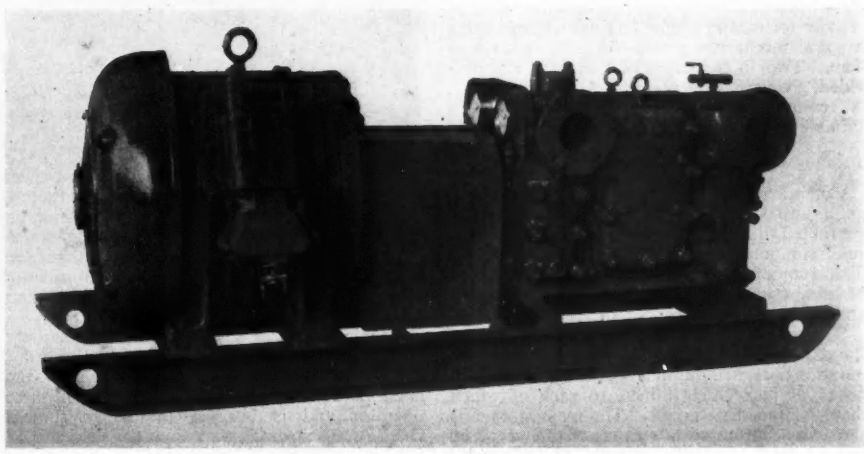
In common with other Megator pumps, the G.H.4 has exceptional self-priming and snoring powers, and can deal with any inflow of water ranging from seepages to full capacity. Under these service conditions the pump often sucks air or a mixture of air and water, but immediately picks up water again as the need arises. This reliability under snoring conditions is of value for intermediate pumps drawing from sumps since level-operated control gear is not required. The suction lift is 20ft.

The new pump embodies the sliding shoe principle, which is a simple mechanism equivalent to a multi-ram reciprocating pump with mechanical valves, and also, as in other "M" pumps, provides for the inspection of the working parts by the removal of a cover without disturbing the drive or breaking pipe connections. There are six plastic shoes arranged in pairs, of which the middle set oppose the end pairs. The pumping action is derived from the rotation of six eccentric discs, which have a diameter of 4·36in, a width of 1·5in and a stroke of 0·7in, and are arranged in pairs set at 120 deg. to one another with the discs of individual pairs set at 180 deg. The discs or rotors fit closely into the plastic shoes, which are rubber lined, and impart a vertical motion to the shoe to cover and uncover suction and discharge ports, while the horizontal motion provides the necessary displacement. The discs and port plates are of heat-treated stainless steel and the former are mounted on a 1¾in diameter shaft which is carried in end bearings. Loads on the bearings, and the bending moment on the shaft are reduced to a low total by the arrangement of shoes and rotors. However, this gives a unidirectional resultant thrust on the bearings, which ensures smooth running even with large bearing clearances.

The shaft is carried in water lubricated synthetic rubber bearings, which have been proved to have a long life under abrasive conditions, such as obtain in mining operations, and carbon-face radial seals fitted externally to the cast iron pump body and provided with a free circulation of water adequate for cooling purposes and for preventing the accumulation of solid matter. Exceptional radial misalignment is permitted by the shaft seals and the shoes which float on the rotors also allow for variations in alignment without affecting the working of the pump. Pressure developed in pumping not only maintains the shoes in their correct relative positions, but ensures a tight seal and helps to compensate for wear. To utilise to the full the flexibility and automatic adjustment to normal wear made possible by the sliding shoe system the rubber bearings and the seals, a special coupling is fitted. This employs "Metalastik" trailing-link mechanism, in which radial misalignment is resolved into angular flexing of the "Metalastik" rubber bushes uniting the links of the coupling. This coupling, which we illustrate, has been developed to accommodate restrictions imposed by the radial face shaft seal and uses "Taperlock" bushes for the rapid and secure fastening and equally rapid removal of the driving and driven hubs. The distance between the ends of the pump and motor shafts allows part of the coupling, the pump and cover and the seal to pass between them without disturbing pump or motor.



Flexible coupling partly dismantled



Direct coupled, skid mounted "GH4" mining pump

British Instrument Industries Exhibition

No. III—(*Concluded from page 54, July 8th*)

W. G. Pye and Co., Ltd.

A VOLTMETER with a resistance of 1 megohm per volt was shown by W. G. Pye and Co., Ltd., Cambridge. This high value of resistance, which depends on the fact that the voltmeter embodies a suspended galvanometer, makes the instrument suitable for many applications beyond the scope of the pivoted voltmeter with its comparatively low resistance.

This new "megohm-per-volt" voltmeter is also able to measure low voltages, the lowest range being 10mV for full-scale deflection. Indication is given by a light spot having a fine hair line which traverses the 5½in scale and allows parallax-free readings to be taken. An accuracy of within ±1 per cent of full-scale deflection is specified. There are ten ranges, from 10mV to 300V. Provision is made for short circuiting the coil automatically when the instrument is switched off and when it is lifted from the bench.

Another interesting exhibit was the Pye "Nanoammeter," which is designed to measure currents of the order of 10^{-9}A and voltages of the order of 10^{-6}V, and is more convenient to use than comparable galvanometers.

The new instrument consists of a galvanometer modulator which converts a small direct current into an alternating voltage, which can be amplified by a thermionic amplifier. The resulting output of the amplifier is applied to the phase-sensitive detector which converts a.c. back to d.c. The d.c. output, generated as a current, is passed through the panel meter and through a feedback resistor. The voltage developed across this resistor is applied to oppose the effect of the input signal. This arrangement stabilises the system against changes of internal gain and ensures linearity and stability. The output current of the instrument may be fed to external circuits and this output may be up to 1mA into 4000 ohms. On the most sensitive range this instrument indicates 1×10^{-9}A full scale and the range switch reduces the sensitivity by 10, 100, 1000 and 10,000 times. When used as a voltmeter on the most sensitive range the instrument indicates 1×10^{-5}V full scale. Used as a "Nanoammeter" the voltage drop at full scale is 10μV, whilst as a voltmeter the resistance is equivalent to 100 megohms per volt. A robust indicating meter with a clearly marked scale is fitted.

An improved version of the Pye two-dimensional measuring microscope was also on show. In the new instrument the two carriages are now fitted with a fully floating split whole nut, and precision ground lead-screws replace the existing design. The longitudinal range is 20cm and the cross traverse 10cm. Micrometer heads are fitted, enabling measurements to be made directly to 0·01mm over a rectangular field of area 200 square centimetres. The microscope may be rapidly focused by a large knurled ring operating a spiral mechanism; the focusing distance is 4cm. Two interchangeable lens cells are provided, giving magnifications of 5 or 20 diameters. A removable plate-glass platform provides a suitable stage for specimen mounting.

Ferranti Ltd.

Computers and their application in commerce and industry were among the exhibits shown by Ferranti Ltd., Hollinwood, Lancs. The "Pegasus" computer, for example, is a new electronic digital computer of medium size, which is capable of being used for a wide variety of computations and analyses in research, commerce and industry.

"Pegasus" is built up from a number of standardised, plug-in, packaged units. Computation is carried out in a high-speed store composed of nickel delay lines, to each of which there is immediate access. The main storage is a magnetic drum with a capacity of over 4600 words. The standard equipment for input and output of information uses punched paper-tape, and auxiliary equipment with punched cards or magnetic tape is under development.

Several sizes of magnetic drums are made by the company; some have nickel-plated surfaces, others have an iron oxide coating bonded with "Araldite." The largest drum is 12in diameter and 10in high. Normally the maximum working capacity is 256 tracks, each carrying 3200 digits, making a total storage capacity of approximately 800,000 binary digits. The maximum access time is 30 milliseconds. Another form of drum is also 12in diameter, but carries only thirty-two tracks, each holding 3200 digits, giving a total of about 100,000 binary digits. A third drum, recently introduced, is 10in in diameter and 7in long; it will carry up to sixty-four tracks with 3200 digits on each, giving a total capacity of about 200,000 binary digits. The maximum access time is 16 milliseconds. Attention has been given to the development of the reading and writing heads for increased signal level and greater reliability.

Baldwin Instrument Company, Ltd.

The transverse profile unit exhibited by Baldwin Instrument Company, Ltd., Dartford, Kent, is a self-contained instrument which makes use of a radioactive isotope to measure transverse variations in weight per unit area of a strip of paper or plastic.

This instrument (Fig. 5) is a development of the Baldwin "Atomat" beta-ray thickness gauge. But, whereas the "Atomat" gives a measurement of the weight per unit area longitudinally, along the web, the new instrument gives a similar record of the transverse profile.

Briefly, the principle of the "Atomat" is that when beta rays or fast electrons from a

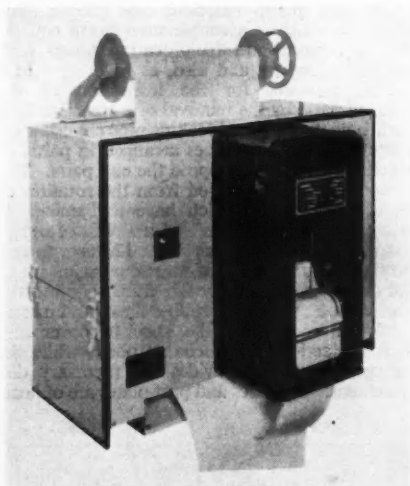


Fig. 5—Recorder for measuring the transverse profile or thickness of sheet paper or board during production—Baldwin

radioactive source are beamed towards a sheet of paper some of the radiation is scattered, some is absorbed and the rest, depending on the weight per unit area of the paper, is transmitted through the sheet. The transmitted radiation is received on a detector, the ionisation current of which indicates the weight per unit area of the sheet.

The transverse profile instrument makes use of the same principle. To make a measurement a sample of paper or board about 12in long is cut across the end of the reel by the machine operator and is inserted in the instrument (Fig. 5). By operating a switch the strip is then fed automatically through the instrument and weight variations are recorded on the chart, one form of which is shown in our illustration. The "set weight" at which the material should be produced is shown on the chart and the chart record of the profile across the web shows any deviations from this set weight.

Elliott Brothers (London), Ltd.

New activities undertaken by Elliott Brothers (London), Ltd., Century Works, London, S.E.13, since the previous exhibition in 1953 were represented on the company's stand.

A prominent exhibit demonstrated the use of the new Elliott electronic digital computer in the solution of commercial and industrial problems, similar to those undertaken by the company's computing service. The connecting link between the computer and the more conventional side of process control is provided by the Elliott automatic "readout" unit, which was shown making a continuous record, on an electrical typewriter, of measured variables which were also indicated at other points on the stand. This "readout" unit can also effect the continuous integration of any of the measured quantities and can indicate when any of the variables deviate from their set values.

On the section of the stand devoted to boiler instrumentation there was a Shotter electrical transmitting mercury manometer flowmeter coupled with a miniature electrical recorder and continuous electrical indicator; the two latter instruments are suitable for graphic panel mounting. Two new instruments on show were the Elliott CO_2 gas analysing equipment for flue gas analysis, and the DCL-Elliott paramagnetic oxygen analyser, specially designed for industrial use. The display included a diagrammatic boiler panel with miniature electrical instruments to indicate variables such as steam, pressure and temperature.

Another section of the stand was concerned with instrumentation in the chemical industry, and here the exhibits included a range of "Drimac" differential pressure transmitters; a new electromagnetic transducer designed to receive small electrical impulses directly from sensing elements (such as thermocouples) and to give a pneumatic output of 3 lb to 15 lb per square inch; and the Elliott-Bendix "Ultra-Viscoson" equipment, which is now being made in this country for the measurement of viscosity by means of ultrasonic vibration.

Baird and Tatlock, Ltd.

An oil-testing centrifuge having a bucket capacity of 100 ml and designed to comply with the requirements of the Institute of Petroleum and A.S.T.M. was shown by Baird and Tatlock, (London), Ltd., 14–17, St. Cross Street, London, E.C.1. All the tests specified can be carried out with a single centrifuge head, making use of appropriate interchangeable accessories. The centrifuge bowl and stand are made of cast aluminium and the head is of aluminium-bronze. It is driven by a three-speed capacitor motor, designed to ensure safe operation in inflammable gaseous atmospheres, and the speed change switch is in a sealed casing to provide flameproof conditions. The motor was specially developed for this drive, to have a low starting torque, gradually increasing to a maximum. Another exhibit was the B.T.L. "Penetrometer," which is designed for the determination of the penetration of bitumen, grease and petrolatum as a measure of consistency, as specified by the Institute of Petroleum and the A.S.T.M. The penetration is defined as the distance in tenths of a millimetre that a standard needle (for bitumen) or a standard cone (for petrolatum and grease) penetrates vertically into a sample of the material under fixed conditions of loading, time and temperature. The B.T.L. "Penetrometer" can be adjusted by sliding the main assembly on a vertical stainless steel rod so that the indicator reads zero when the tip of the needle or the cone is placed at the level of the surface of the sample. The needle and cone can move without appreciable friction, The instrument is capable of recording penetrations up to 400 divisions, each division corresponding to 0·1mm. Levelling screws and a spirit level are provided to maintain the needle/cone shaft in a truly vertical position. The instrument may be assembled either in hand-operated or automatic forms.

Underground Train Speed Measuring Apparatus

A NEW equipment for measuring the speed of Underground trains, which has been designed by the Signal Department of London Transport, incorporates a method of detecting the speed instantaneously instead of over a measured stretch of line, as with the equipment hitherto used.

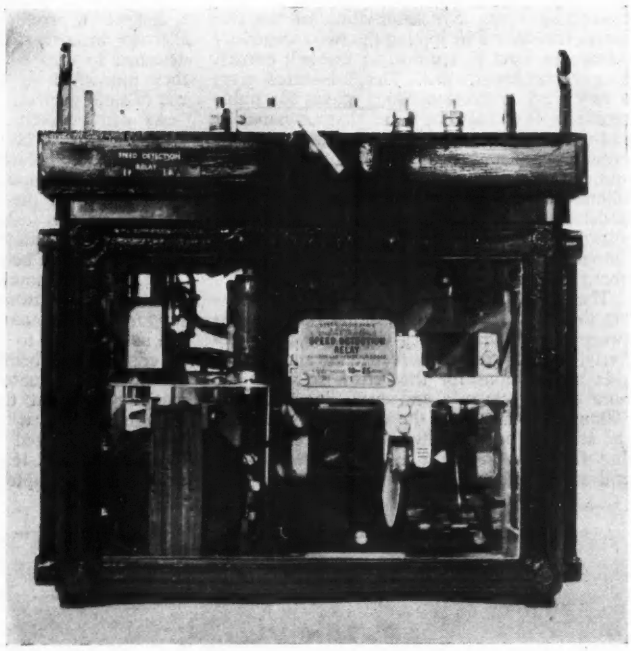
Speed control signalling has been used by London Transport since 1948 in order to overcome the "checking back" of a series of trains which takes place when a train ahead is held in a station platform for an abnormally long period by heavy traffic. Under this system a train standing at a platform is protected by the home signal behind it, and the position of the home signal is decided by the maximum distance needed to halt a following train travelling at maximum possible speed if it should pass the home signal at danger and be automatically "tripped." When a train remains in a station platform for more than thirty seconds the train behind will be halted by the home signal. This halt between stations and the consequent need to decelerate and re-accelerate means that any station delay to a single train will affect a number of following trains and disorganise the running of the whole service. The principle of speed control signalling is to enable the home signal in such a case to clear earlier, provided that the train approaching it is travelling at the required reduced speed.

Where speed control signalling is applied additional signals, usually either one or two, are interposed between the original home signal and the platform to protect the train standing in the platform. The speed control of a signal has previously been achieved in London Transport practice by arranging to time the train over a fixed length of track, the length being such that it takes approximately 4½ seconds to pass over it at 25 m.p.h. A train passing into the timing section brings into operation a time relay, which is so set as to complete its operation and close an electrical contact in 4½ seconds. If the speed of the train is 25 m.p.h. or less over the timed stretch the relay will have closed its contact before the train reaches the end of the section. In this case—but not otherwise—the signal will clear as the train approaches so that it can be passed without a halt. An intermediate home signal will next be approached and this is similarly speed controlled, but is arranged only to clear when the train speed is still lower, generally 20 m.p.h.

The overall effect of speed control is twofold. First, it keeps a train in motion when it would otherwise be halted with consequent loss of running time. Secondly, it enables a train, under conditions of perfect safety, to approach somewhat closer to one held at the platform than would otherwise be the case. Both these factors have the effect of "ironing out" the repercussions of long station stops, improving time-keeping and preventing delays building up behind heavily loaded trains. Speed control signalling of this kind is installed on the Piccadilly line between Green Park and King's Cross and on the Central line at Liverpool Street and it has resulted in a substantial improvement in the smooth running of trains under rush-hour conditions.

This design of apparatus, however, does not enable the maximum advantage to be gained from speed control signalling because it is only possible to measure the average speed over the timed section. In the case of a train slowing down rapidly the average speed may be substantially higher than the speed at the end of the timing section, the latter speed being really the critical factor. With this equipment the driver's operation needs considerable skill at the position of the timed section to regulate his speed exactly.

A new speed detector, evolved after experiments by Mr. R. Dell, the signal engineer, has been introduced to overcome this difficulty and measure the speed instantaneously. For this detector a length of what appears to be a dummy (positive) current rail 12ft long is fitted to the side of the track. The surface of this rail, which is illustrated herewith, is of stainless steel and beneath it are twelve permanent magnets and coils, the magnets being spaced at distances of 9in. The positive shoes of the passing train run over the inductor and induce a current in the coils. The flux from the permanent magnets is attracted up to the iron shoes as they pass and this causes a variation in the flux reaching the coils below, so that a small alternating electrical current is generated in the coil. The frequency of the current varies exactly in proportion to the speed of the train's passage over the magnets, and hence is a measure of the speed of the train. The current generated is amplified by a specially designed valve amplifier and is fed into a relay which has been designed to respond only to alternating current below a given frequency. When the relay operates the speed controlled signal ahead will clear. A high degree of accuracy, with measurements correct to half a mile per hour has been achieved with the speed detector.



Train speed detection relay

The detector enables the speed to be measured at the most convenient point in relation to the signal, and the fact that the detector makes repeated speed checks as each shoe of the train passes over the inductor obviates the necessity for the driver to judge his speed closely at one critical point on the track. Even if the driver's speed may be too high as the front of the train passes over the inductor, the signal will clear if the speed is down to the proper level when the rear current shoes of the train reach the inductor. An important advantage is that the new speed detector suits the varying styles of driving of individual drivers.

Speed control signalling utilising the Dell detector is to be brought into use as soon as possible on the heavily used central area section of the District line, a first installation having already been brought into use at Victoria. The remainder of the apparatus is on order to enable all signalling between Gloucester Road and Mansion House to be equipped as quickly as possible. The research department of Westinghouse Brake and Signal Company Ltd., developed the special relay and amplifier required for this apparatus and is now undertaking the manufacture of the equipment required for the District line.

Dummy conductor rail installed beside the track for measuring the speed of underground trains

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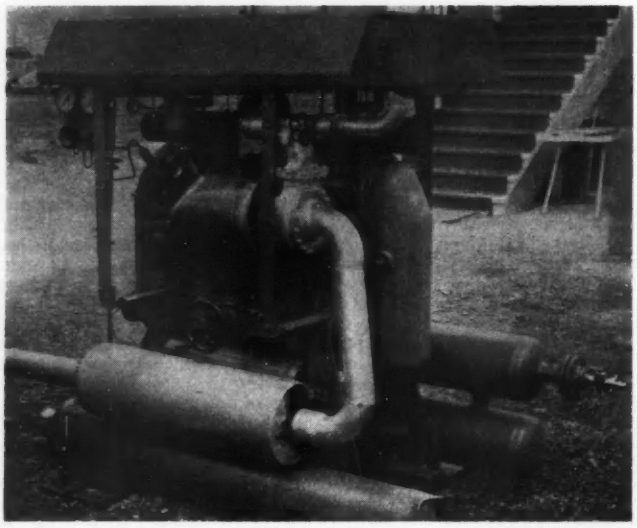
ALUMINIUM ALLOY CLADDING.—We have received from Imperial Chemical Industries, Ltd., Millbank, London, S.W.1, some details of the aluminium alloy wall and roof cladding made by the company and known as "Kynalok Secret-Fix" cladding. The system is based on a corrugated aluminium panel, 1ft 8in in width. Adjacent panels are held by an aluminium cover strip, so designed that the heads of the fixing bolts are secured in a groove on its underside. The purlins or sheeting rails carrying the cladding have clips through which the bolts are placed, to attach to the cover strips. A lining board may be fixed inside the cladding by spring clips.

Air-Cooled Free-Piston Compressor

THE free-piston compressor shown in the accompanying photograph has been developed by Freiflug Kompressorenbau G.m.b.H., Dusseldorf, Lakronstrasse 4–6. First shown to the public at this year's Hanover Fair, it operates on the two-stroke diesel principle. Its single-cylinder air cooled engine develops 30 h.p., giving an output from the compressor cylinder of 3 cubic metres per minute of air compressed to 7 atmospheres gauge. This high rating is made possible by cooling the machine with an exhaust-driven blower.

Our second illustration shows the principle of the design, in which motor and compressor have been completely separated, so that additional heating of the air by the engine piston is avoided. The machine basically consists of two pairs of opposing pistons linked by bell cranks and connecting rods. Synchronisation of the two halves is obtained by joining the two eccentrics *I* which are fixed in relation to the bell cranks, by a synchronising rod *J*. This, it is stated, gives a very rigid connection which makes for stable running. It will also be noted that no glands or stuffing-boxes are employed. Motor and compressor cylinders have the same bore (100mm), and the stroke is also the same, varying from 109mm per piston when idling to 141mm when under full load, the maximum separation of the pistons being, therefore, slightly over twice that amount. The frequency of the machine is about 1300 cycles per minute.

The pistons are stepped so that besides sweeping the engine and compression cylinders they sweep out annular spaces which serve, respectively, to compress the scavenge air and to provide air cushions for the return stroke. The bore of the scavenge and cushion cylinders is 200mm. By means of the valve system shown, the scavenge air is delivered to the crankcase, and from the crankcase it is admitted to one end of the engine cylinder (uniflow scavenge).



30 h.p. free-piston diesel-driven compressor. In front may be seen the exhaust turbo-blower which provides cooling air. The hand valve admits starting air

In order to start the engine, the compressor pistons are first pushed together by means of a hand lever which engages with one of the bell cranks. Starting air is admitted to ports in the air cushion cylinders (not shown in the drawing). These ports are initially covered by the pistons, which are slowly separated by the air which is leaking past the piston sides into the annular spaces. This gives time to open the valve fully without requiring any holding device for the pistons, which are thrown apart suddenly when their edges uncover the ports. The air in the engine cylinder is then compressed, fuel is injected and the engine fires. Since very high compression ratios can be employed, starting is a straightforward matter even in extremely cold weather. Air for starting is supplied from a 7-litre bottle, charged to 6–7 atmospheres gauge from a second 9-litre container which in turn is kept at a high pressure by a bleed-off from the engine. In an emergency recharging may be carried out by means of a hand compressor.

It is claimed for this design that all parts are easily accessible and that maintenance, therefore, is a very simple matter. Lubrication is centralised, and all journals work in needle bearings. The illustrated version is intended as a portable or stationary compressor for the building and engineering industries and without skid-base or undercarriage weighs about 450kg. By combining a number of units, the output range can be extended to 15 cubic metres per minute.

Commutator Lathe

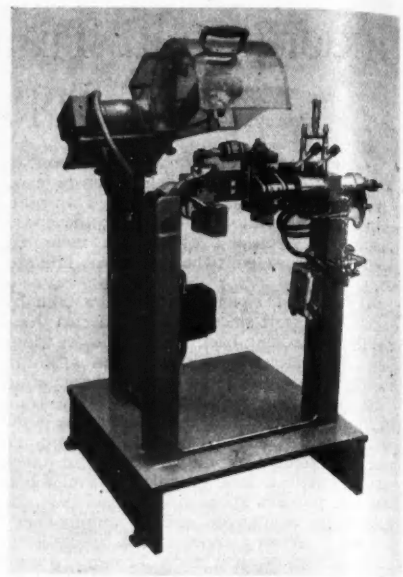
A SPECIAL production lathe made by Small Electric Motors, Ltd., Beckenham, Kent, is designed to turn commutators supported from their individual armature journals and without use of shaft centres.

As can be seen from the illustration, the lathe has a heavy plate base on which are rigidly mounted three columns. The driving motor of about ½ h.p. is mounted on a counterbalanced base hinged on the head of the rear column. An arm extends forwards from the motor base and on it are mounted two spaced pulleys over which the driving belt passes.

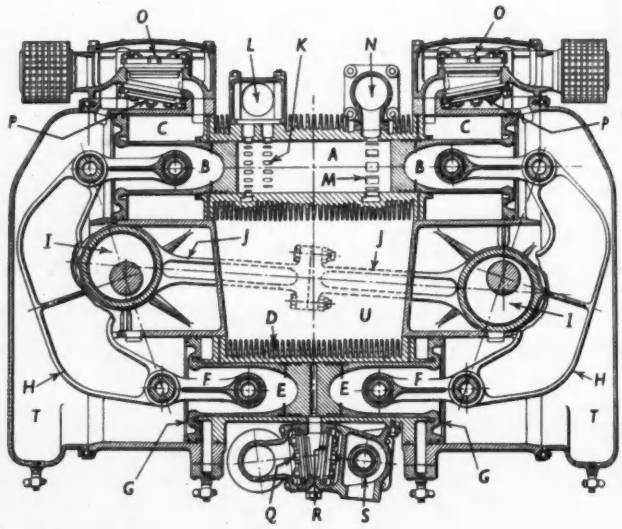
A bedplate mounted between the two front columns carries two vee support blocks which support the commutator on its journals, and which can be spaced up to 12in apart to suit the length of commutator being handled. A tool block on the bed is actuated by a double-acting pneumatic cylinder at the top of the right hand column, With a standard tool block, the tool can be adjusted to machine commutators up to 2¼in diameter. If required, however, the machine can be adapted to take up to about 4in diameter. The stroke of the tool is adjustable and machining can be effected in either direction of travel. A tool relieving mechanism comes into effect at the end of the cutting stroke as the pneumatic piston automatically begins the return stroke.

When a commutator has been placed on the tungsten carbide faced vee supports the driving arm is drawn down until the length of driving belt between the two outer pulleys engages the armature core. As the driving belt contacts the commutator the arm is automatically locked, the motor is started, and the air supply valve to the pneumatic slide cylinder is opened to start the machining cycle. At the end of the cutting stroke the air supply to the cylinder is reversed and with the tool withdrawn from the work the tool block is returned to its starting position. At this point the motor is switched off, an electromagnetic brake applied and the driving arm lock is released by operation of a small lever and the arm is automatically raised for changing of the workpiece. Although the depth of cut is set, the tool can be fed forwards a small amount by operation of a lever to enable a cut to be taken over slightly undersized commutators.

The height of the vee blocks which support the work can be varied to suit different diameters of shaft journals up to a maximum size of 0·843in. A turret setting block used for this purpose provides for six preset diameters. Tungsten carbide tipped or diamond tools are used on the machine and the cutting speed is 800ft a minute.



Commutator lathe with driving arm raised and a commutator on the vee blocks ready for machining

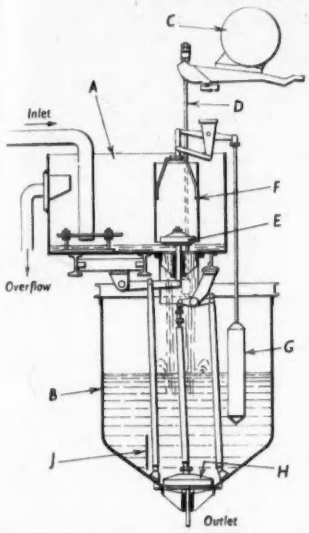


A—Motor cylinder.
B—Motor piston.
C—Scavenge piston.
D—Compressor cylinder.
E—Compressor piston.
F—Connecting-rod.
G—Air cushion.
H—Bell crank.
I—Eccentric.
J—Synchronising rod.
K—Air inlet ports.
L—Scavenge air duct.
M—Exhaust ports.
N—Exhaust pipe.
O—Suction valve.
P—Delivery valve.
Q—Compressor motion valve.
R—Delivery valve.
S—Pressure maintaining valve.
T—Crankcase.
U—Cooling air space.

Section through free-piston compressor

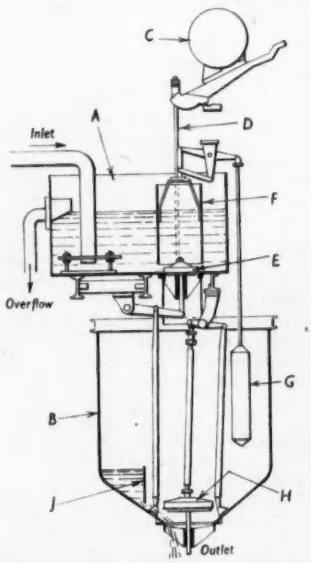
Weighing Machine for Liquids

FOR the automatic weighing of liquids at rates up to 150 tons per hour and in batches of up to 3½ tons at a time, George Fletcher and Co., Ltd., Litchurch Lane, Derby, has produced a balance of which the principle is illustrated in the drawings which we reproduce here. The



Automatic weighing machine showing raised tank being filled

machine consists of three main parts, the supply tank *A*, the weigh tank *B*, and the weigh-beam and counter-weight *C*, *B* and *C* being connected through rods so that the empty weigh tank is held in its top position, with valve *E* held open by a linkage attached to the tank. As the tank fills up, the float rises and depresses a serrated baffle *F*, thus reducing the rate of flow. When the weight of liquid in the tank overcomes the counter-weight, the tank sinks, thereby opening



Weighing machine nearing end of discharge with tank in bottom position

the discharge valve *H* and closing the valve *E*. The final discharge is slowed down by the baffle *J*, an arrangement which allows the cut-off point to be reached without over-shooting. The counter-weight then raises the tank back to the filling position. The machine is stated to be suitable for potable liquids, chemicals, oils, hot or cold water and other liquids up to a viscosity of 150,000 S.S.U. Rate of operation is controlled by an oil buffer, and an automatic counter registers either the number of fillings or the total tonnage. The settings can be locked and any Government excise seals affixed as may be required. An automatic sampling device can be fitted, also a tank for automatically adding a predetermined amount of another liquid to each batch.

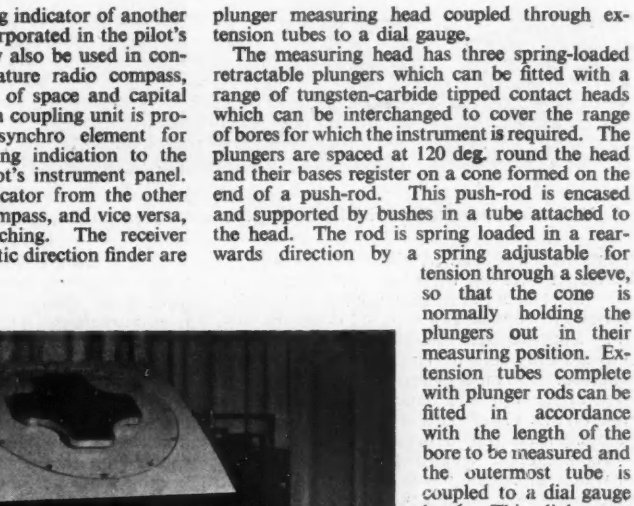
Subminiature Radio Compass

A NEW radio compass, manufactured by Marconi's Wireless Telegraph Company, Ltd., and designed for use in the m.f. band, is believed to be the smallest and lightest of its kind yet developed to such an exacting specification, where the total weight of the main units is less than 10 kg. It has been developed for use in all kinds of aircraft and is primarily intended for pilot operation.

The direction finding system is of particular interest. Contrary to conventional practice, the receiving aerial is fixed, being in the form of a sealed iron-cored crossed loop having no moving parts, and having a maximum height of less than ¾in. A low-drag loop installation can therefore be achieved without recourse to full suppression, or alternatively the aerial may be fully recessed into the fuselage, if desired. Even in the latter case it is not necessary to cut a large hole in the fuselage.

A Bellini-Tosi type of direction finding system is employed, the goniometer being embodied in the bearing indicator. Bearing presentation is by means of a scale pointer, driven directly from the shaft of the goniometer search coil.

Should a suitable bearing indicator of another equipment already be incorporated in the pilot's instrument panel, this may also be used in conjunction with the subminiature radio compass, with consequent economy of space and capital outlay. For this purpose a coupling unit is provided, which includes a synchro element for transmission of the bearing indication to the slave indicator on the pilot's instrument panel. Transfer of the slave indicator from the other equipment to the radio compass, and vice versa, is made by remote switching. The receiver circuits of the new automatic direction finder are contained in two rack-mounted main units and are remotely operated from a single control unit. Plug-in sub-units are used for ease of replacement. The frequency coverage is 200–1700 kc/s, covered in three ranges. A further saving of space and weight is achieved by dispensing with the usual rotary transformer, as the 28V d.c. aircraft supply is used for h.t. circuits.



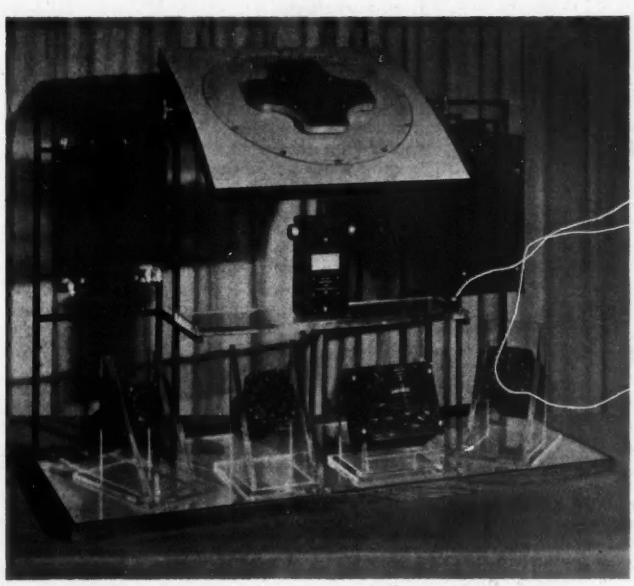
Arrangement of gauging head, push-rod assembly and dial gauge head

Dial Gauge for Long Tube Bores

AN instrument for accurately measuring the bores of tubular drilling sections from 1¼in to 2¾in diameter and up to 18ft long has been developed by British Indicators, Ltd., Sutton Road, St. Albans, Herts, for the Shell Petroleum Co., Ltd., The general construction of this instrument can be seen in the drawing we reproduce. It consists essentially of a retractable plunger measuring head coupled through extension tubes to a dial gauge.

The measuring head has three spring-loaded retractable plungers which can be fitted with a range of tungsten-carbide tipped contact heads which can be interchanged to cover the range of bores for which the instrument is required. The plungers are spaced at 120 deg. round the head and their bases register on a cone formed on the end of a push-rod. This push-rod is encased and supported by bushes in a tube attached to the head. The rod is spring loaded in a rearwards direction by a spring adjustable for tension through a sleeve, so that the cone is normally holding the plungers out in their measuring position. Extension tubes complete with plunger rods can be fitted in accordance with the length of the bore to be measured and the outermost tube is coupled to a dial gauge head. This dial gauge head is fitted with a pistol grip, and through a trigger the push-rod is pressed inwards to allow the plungers to retract when entering the measuring head in the bore to be gauged.

Up to five sections of gauging extensions can be assembled and quick rings fitted on the extensions centralise the tube in the bore and support its weight to ensure accurate reading. The dial gauge reads in increments of 0·0005in over a range to suit the various sizes of plunger contact heads.



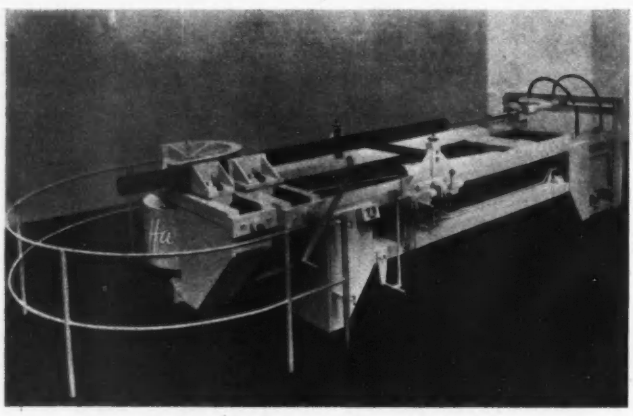
Main units of subminiature automatic direction finder

Tube Bending Machine

A MACHINE capable of cold bending tubes up to 3in nominal bore up to 180 deg., which has been made to special requirements by Chamberlain Industries, Ltd., Staffa Road, London, E.10, is illustrated below. The machine is hydraulically operated and it is stated that a normal bending cycle can be completed in twenty-five seconds.

The fabricated base of rolled steel sections and heavy plate has a vertical shaft mounted in ball and roller bearings at the front end. This shaft has a head keyed to its upper end and a sprocket wheel is fixed midway between the bearings. Through a triplex chain acting on the sprocket wheel the head is turned for the bending operation by a high-pressure hydraulic ram connected to one end of the chain. A pressure die adjacent to the swinging head takes the reaction of the straight part of the tube during bending. A small hydraulic ram attached to the opposite end of the chain returns the head to its starting position after the bending operation.

In the bending sequence the tube is pushed into the machine from the head end over a mandrel and a clamp on the swinging bed is wound in to hold the tube against the centre former. The adjacent pressure die on a similar clamp head is then brought forward into position. On the hydraulic control valve lever then being moved, the main ram operates the chain to pull on the sprocket and rotate the head. As the swinging head rotates the tube is drawn out over



Hydraulically-operated machine for bending 3in tubes up to 180 deg.

the mandrel and bent. At the end of the required bending movement a second hydraulic control valve actuates a retraction ram and the mandrel through its support bar is pulled down the tube away from the bent section. On the clamp and pressure die being unclamped the tube can be removed. The main control lever is then pushed over in the opposite direction and the return ram on the chain pulls it back to return the swinging head to its initial starting position.

The hydraulic system is fed by a power pack in which an electric motor drives a swash-plate pump delivering oil at a pressure of 5000 lb per square inch to the machine. The maker states that machines of this design can be supplied to bend tubes up to 12in nominal bore.

Book of Reference

Timbers of South-East Asia. Timber Development Association, 21, College Hill, London, E.C.4. Price, free.—A booklet entitled *Timbers of South-East Asia* has recently been added to the T.D.A. series as a companion volume to *Timbers of West Africa* and *Timbers of South America.* It contains descriptions of some forty timbers of interest in the British market, together with notes on their uses, properties and working qualities. The timbers are arranged in alphabetical order of standard names, in accordance with B.S. nomenclature of commercial timbers. References to kiln schedules follow those suggested by the Forest Products Research Laboratory.

Jet Noise

By F. B. GREATREX*

No. III—(*Concluded from page 47, July 8th*)

In this paper, presented recently before the Anglo-American Conference of the Aeronautical Society and the Institute of Aviation Scientists at Los Angeles, detailed measurements made of the noise field round various jet engines, particularly the "Avon," are described. Of the various noise reduction devices tested, the "toothed" nozzle has been discarded owing to its adverse effect on engine performance. A series of "corrugated" nozzles having no effect on engine performance has been found to give worthwhile noise reductions. The three main conditions under which jet noise affects the community are examined—during ground-running, shown to be effectively silenced by a ground muffler; from aircraft passing overhead during take-off and approach, measured to be 9 db worse on take-off with standard jet engines than with propeller engines; and inside aircraft.

Practical Problems

THE noise measurements already described illustrate the physical quantities associated with the noise of jet engines, but not the way in which this noise affects individuals who are subjected to it. Discounting the service personnel who have to operate and work near military aircraft, and those who do the same sort of work at engine and aircraft manufacturers' and airline operators' airfields—all of whom get paid for this work—there are two main classes of people to whom the noise of a jet engine can be a serious problem. The first and very much more important class includes, of course, all those who never travel by air, but have to put up with the interminable noise of engine running on the ground from civil or military airfields, and the alarming noise of aircraft passing overhead in the neighbourhood of a civil airport. The second class includes the airline passenger whose degree of tolerance to noise is probably greater, even if it is inversely related to the fare he pays.

Thus there are three main conditions under which the noise needs to be examined more fully, from engines being run on the ground, from aircraft passing overhead during take-off and approach, and as experienced by the passenger inside the aircraft.

Noise from Ground-Running of Engines.†—Strictly this includes the noise during an aircraft take-off, but this short duration noise is of less importance than the noise from engines being checked on the ground which is very often a lengthy process. Since even a mile away noise levels can be high enough to interrupt conversation completely, it is now universally agreed that some solution to this problem must be found. The one which is being generally adopted is to use some form of ground muffler, either a semi-portable affair which can be wheeled up to the aircraft, or a permanent building in which case the aircraft has to be moved into the right position.

The muffler effectively reduces the noise radiated in a rearwards direction, but is not sufficient by itself, since a lot of noise is still radiated forwards out of the mouth of the muffler—and it is difficult to avoid this, since of course the whole object is to test the engines as installed in the aircraft, and their behaviour must not therefore be in any way affected by the presence of the muffler. The function of the pen is to absorb much of the remaining noise in its sound-absorbent material so that the noise radiated out of the top of the pen (which is heard outside the "shadow" of its walls) is considerably reduced. Fig. 18 shows the net result, the noise level measured at a distance of 1000 yards from the aircraft in its "pen," 20 deg. off the jet axis, with the engine running at maximum revolutions per minute with the afterburner in operation. The background noise measured at the same point is shown for comparison; it can be seen that even in this quiet residential area the noise is unlikely to be disturbing.

Clearly the expenditure of about £10,000 on a pen of this sort is a complete solution to the problem of noise from ground running engines of a single-engined aircraft, provided that the inconveniences of moving the aircraft in and out of the pen are accepted. For multi-engined aircraft the cost will of course be greater, but on the other hand there is less likelihood of having to cater for afterburning.

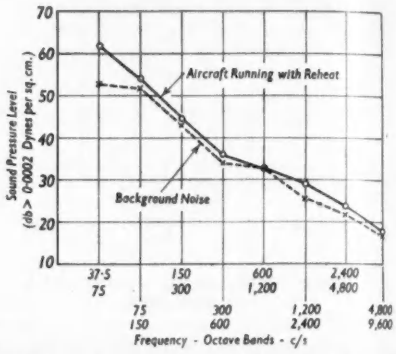


Fig. 18.—Noise measurements at 1000 yards, 20 deg. off jet axis, from aircraft with "Avon" engine at maximum r.p.m. with afterburning. Aircraft in ground-running pen

Noise from Aircraft During Take-off and Approach.—In general this noise is a serious problem only in the neighbourhood of civil airports, not military airfields with their much less frequent aircraft movements. To obtain some idea of the magnitude of this problem the series of tests mentioned at the beginning of this paper were carried out. The noise from four different aircraft, "Comet," "Constellation," "Stratocruiser" and "Viscount," was measured at a point in line with and 1 mile from the end of the runway as they flew overhead during take-off and approach to land. Details of the aircraft and their engines were given in Table I. The noise was recorded on an E.M.I. tape-recorder running at a tape speed of 15in per second, the microphone being an S.T. C. type 4021a. This was replayed into the S.T. C. objective noise meter and octave band analyser and the output in each octave band recorded on a Bruel and Kjaer graphic level recorder. For the take-off runs the aircraft all used initial climb power on their engines and flew along the same flight path passing over the measuring station at a height of 500ft—rather on the high side for a typical operation, but it was felt that a comparison at constant height was of most value. For the approaches it was not possible to fix an altitude and each aircraft made a standard approach aiming to be at a height of 50ft when over the end of the runway—in this case the height over the measuring station varied considerably, 240ft for the "Viscount," 280ft for "Comet" and "Constellation" and 400ft for the "Stratocruiser." In every case six runs were made, and the results averaged, though the difference between runs was very slight.

The variation of noise with time in each octave band during the take-off is shown in Fig. 19, for each of the four aircraft. In all cases the maximum noise intensity is not reached until after the aircraft has passed overhead, but this effect is much more pronounced in the low frequency noise of the "Comet" which is radiated at small angles to the jet axis. From 150 c/s to 1200 c/s the "Comet" produces considerably more noise than the other aircraft,

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† This paper is only concerned with the noise from jet engines as installed in aircraft; silencing of engine test cells is assumed to be no longer a problem.

but at higher frequencies the "Constellation" is just as noisy; this is due to its engine exhaust noise which is very much reduced on the "Stratocruiser" with its exhaust turbo-supercharger. The "Viscount" also produces little exhaust noise, its noise being concentrated in the 75–150 c/s and 2400–4800 c/s bands, containing the propeller and compressor rotational noises respectively.

The variation of total noise with time was shown in Fig. 1 for both take-off and approach conditions, and it can be seen that on take-off the noise from the "Comet" remains above the 80 db level over a period of nearly twenty-seven seconds, and over the 100 db level for four seconds. In this last respect it is much worse than any of the other aircraft.

The maximum values of total noise for the various aircraft during take-off are as follows :

	Decibels
"Comet"	106
"Constellation"	102·5
"Stratocruiser"	99
"Viscount"	94

This is not strictly a fair comparison of the different types of engine, since the aircraft sizes and engine powers vary very widely. If the figures are all corrected to the same all-up weight as the "Comet" on the reasonable assumptions that noise is proportional to power, and that engine powers will vary in proportion to all-up weight, then the "Stratocruiser" and the "Viscount" give nearly the same result, and the table of maximum noise levels during take-off becomes as follows :

	Decibels
Jet-engined aircraft	106
Propeller-engined aircraft :	
With exhaust noise	102·5
Without exhaust noise	97

The curves obtained during the approach tests showed that the predominating noise from the "Comet" was the high-frequency noise from the compressors, which is only audible above the jet roar at these very low (relative) jet velocities. If the maximum values of total noise are corrected to the same aircraft all-up weight in the same way as before, and to the same 500ft height as during the take-off tests by the inverse square law, then the "Comet" comes out rather noisier than the other three aircraft, which are all within $\pm\frac{1}{2}$ db of each other. The resulting comparison of maximum noise levels during approach is as follows :

	Decibels
Jet-engined aircraft	97·5
Propeller-engined aircraft	94·5

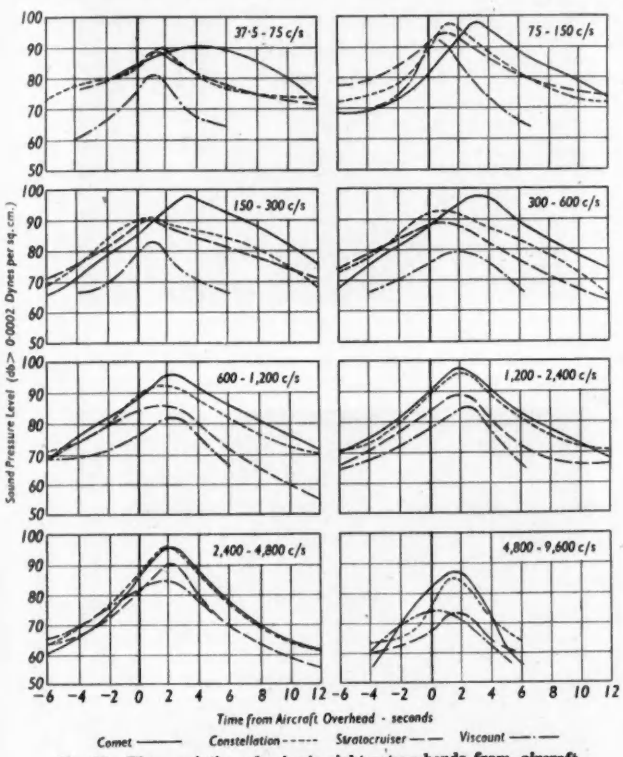

Fig. 19—Time variation of noise in eight octave bands from aircraft passing overhead on take-off

The conclusion to be drawn from these tests is that the noise from a jet-engined aircraft will be about 9 db higher during take-off, but no worse during the approach than the worst noise from a quiet piston-engined aircraft of the same all-up weight. If the latter can be operated without too much disturbance to residents in the neighbourhood of the airport, but only just, then the present noise level from jet engines during take-off must be reduced by about 9 db for satisfactory civil operation. How can this be achieved ? Not, of course, just by throttling back to three-quarter power and using up the engine failure safety margins as has been seriously suggested (see reference 6). Obviously the use of a by-pass engine such as the "Conway" should give the required result ; by the use of devices such as corrugated nozzles it should be possible to bring the noise from the ordinary jet engine down to the desired level, and from the by-pass engine to a lower level still. Incidentally, it should now be possible to calculate the noise from a jet-engined aircraft under conditions such as during take-off from the basic data which is becoming available on jet noise. The calculation has been carried out for this particular take-off test case on the following assumptions :—

(1) The aircraft speed has no effect on the noise pattern except in so far as its level depends on the relative velocity between jet and air (jet velocity was 1640ft per second, aircraft velocity 260ft per second, in these tests, so that total noise contours for 1380ft per second were used).

(2) The values at 200ft radius can be applied at greater distances on the inverse square law, and the noise received at the ground at any moment estimated from the aircraft flight path and incidence, and the time taken for the noise to travel from the aircraft to the ground.

(3) The noise from a pair of engines close together is $1\frac{1}{2}$ db greater than from a single engine. (This is quite arbitrary, but it is known that the increase is certainly less than 3 db.) A further 3 db is, of course, added for the second pair of engines.

Fig. 20 shows the comparison between measured and predicted values, and the agreement is certainly good enough to justify the use of calculated figures for other conditions and other points in the noise field. Similar calculations using the corrugated nozzle with six corrugations at 7·95in depth, show that the peak noise level should be reduced by about 8 db.

Noise Inside Aircraft.—No reliable tests have yet been carried out to prove the point that the significant velocity for jet noise is the relative velocity between jet and air, but the fact seems to be universally acknowledged. This means that even when an aircraft is only just airborne the noise level has dropped by about 4 db or 5 db relative to that when stationary on the ground. At low altitudes therefore it will only be during the actual take-off run that the noise problem inside the aircraft is at all severe. It might be thought that at high altitudes, on the other hand, with the greatly over-choked jet (jet pressure ratios of at least 4 will be occurring during cruising flight) a large "screech" component of noise would be observed. However, none of the noise measurements made inside the cabin of the "Comet" have ever detected this effect, and presumably again the greatly reduced relative velocity between jet and air has an overwhelming effect. It seems, therefore, that the take-off case is the only serious one to the passenger. It is probable that he will be prepared to tolerate this noise, provided (as will be the case) that the aircraft is quiet for the remainder of the flight. However, if it is necessary to alleviate it, a lot can be done by suitable design of the aircraft layout to avoid the high-intensity regions of the noise field, now that reasonably

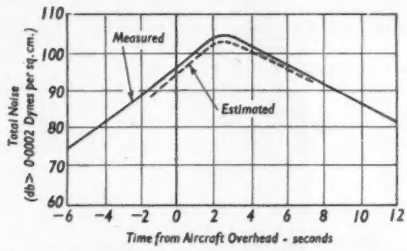

Fig. 20.—Comparison of measured and estimated time variation of total noise from jet-engined aircraft of 110,000 lb A.U.W. passing 500ft overhead on take-off

full information on this is becoming available. Noise reductions can, of course, also be obtained by the use of quiet types of engine and nozzle.

No mention has yet been made in this paper of the structural fatigue problems associated with jet noise, but this is not for the lack of awareness of its importance. Precisely the same arguments just used apply to this problem also ; it is only serious under ground running and take-off conditions, and it will be necessary to design the aircraft and use suitable engines and nozzles in such a way as to avoid trouble.

Conclusions

(1) The high velocity jet from a jet engine is evidently a very powerful source of noise, capable of disturbing the peace of large numbers of people. However, its characteristics are becoming known, and some means of reducing its intensity have been found.

(2) These will make the noise from civil aircraft tolerable, at least to the extent that the noise from jet-engined aircraft will be no worse than that from propeller-engined aircraft of the same all-up weight. On the other hand, it is doubtful if the noise from military aircraft using afterburning in flight will ever be reduced to the same level, though it will, of course, have to be tolerated for the sake of its military necessity. Fortunately, the noise from prolonged ground running can be effectively silenced, even when afterburning is used, at a not unreasonable cost.

(3) The passenger in the jet-engined airliner is unlikely to be greatly affected by jet noise since it is only troublesome at take-off, but both the noise and its associated structural fatigue problems will have to be considered in the design of the aircraft.

These conclusions refer strictly to the present generation of jet engines. The use of engines of very much greater thrust, or the widespread adoption of rocket engines, for example, will raise new problems, and further research into methods of control will therefore be needed to keep pace with increases in noise produced.

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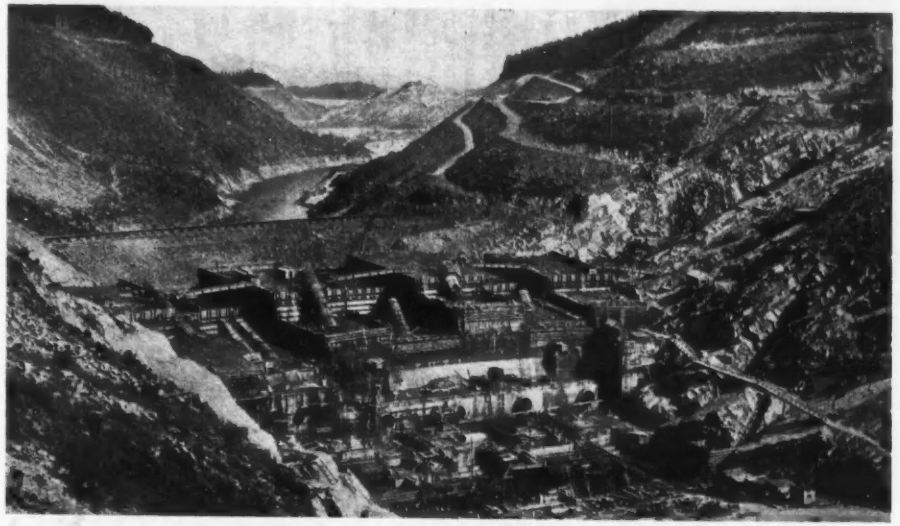
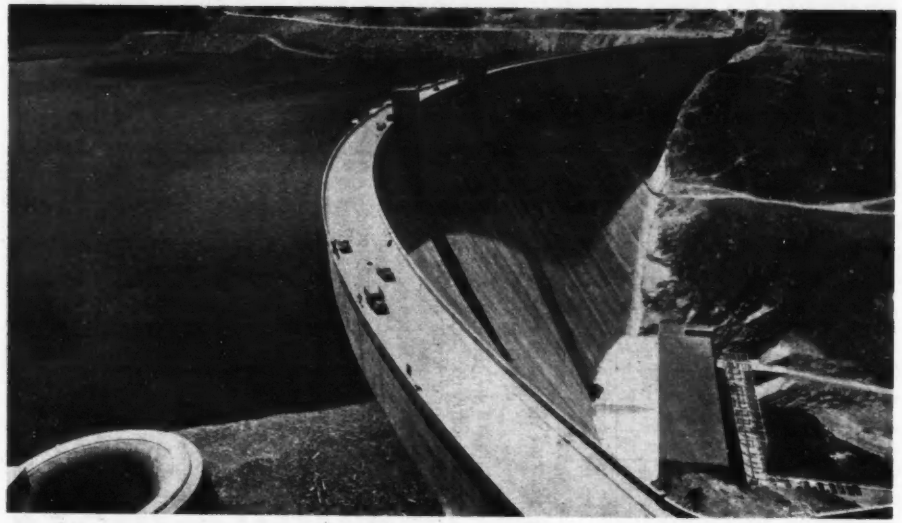
HUNGRY HORSE DAM IN MONTANA

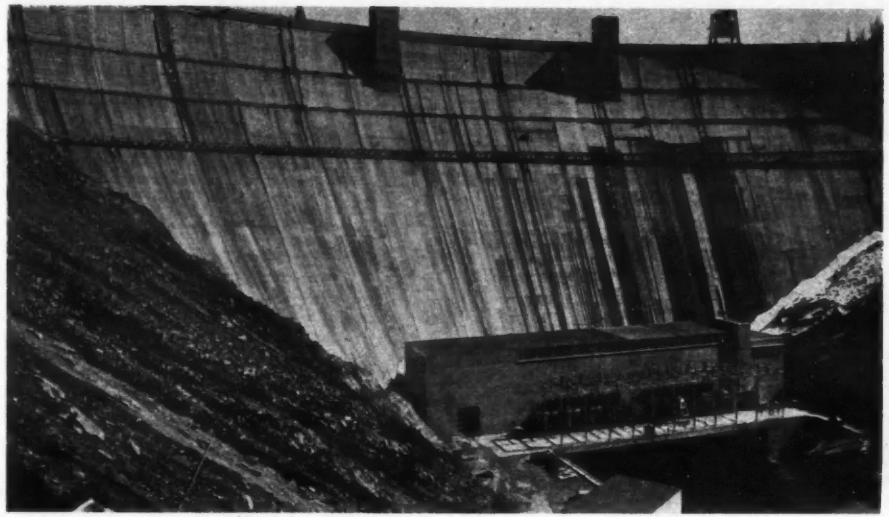


Power station and channel section of dam during construction

Right abutment and channel section of dam during early stage of construction



Completed dam with intake structure of "Morning glory" spillway in left foreground



Downstream face of dam approaching completion, with power station, and river outlet valve house in foreground

Hungry Horse Dam in Montana

BY OUR AMERICAN EDITOR

No. 1

The Hungry Horse dam and power station of the U.S. Bureau of Reclamation have now been in full operation for over a year. The Hungry Horse project is a combined power generation and flood control scheme within the Columbia River system and is situated in north-western Montana. The dam is a concrete arch gravity structure, 2115ft long at the crest and 564ft high, and the power station has a total generating capacity of 285MW.

THE Hungry Horse dam has been constructed in north-western Montana on the south fork of the Flathead River about 5 miles upstream from its mouth. The dam impounds approximately 3,500,000 acre-feet of water and has a usable storage capacity of 2,980,000 acre-feet. The reservoir is now being used for both hydro-electric power generation and flood control, and has made possible an increase in the power generation capacities of the Polson, Thompson Falls, Grand Coulee, Rock Island, and Bonneville dams due to improved river regulation.

Irrigation was practised as early as 1885 in the Ashley Creek area of the Flathead River valley by individual farmers. The Ashley irrigation district was formed in 1897 to serve 1637 acres. In 1909 the Montana legislature passed a revised State irrigation district law and the Ashley irrigation district became the first district in the State to be formed under this law. In the more recent past, local interests had for some time desired a reservoir at the Hungry Horse site to generate power and control floods. The U.S. Geological Survey made field studies during 1934 and 1935, resulting in the issuance of several maps which formed the basis for the project field investigations by the U.S. Bureau of Reclamation. In June 1943, due to the wartime need for power, a serious suggestion was made to raise the level of the Flathead Lake, about 7 miles downstream from Kalispell, Montana, and thereby increase the capacity of existing power plants on the Columbia River. Inasmuch as this would have inundated a large part of the Flathead Valley and flooded the streets of Kalispell, residents of the area protested so vigorously that the Hungry Horse scheme was approved instead. The name of the project, incidentally, comes from Hungry Horse Creek, a small tributary entering the river about 2 miles upstream from the dam. This creek obtained the name when several half-starved horses were found in the snow-filled valley during the early days of the region's settlement.

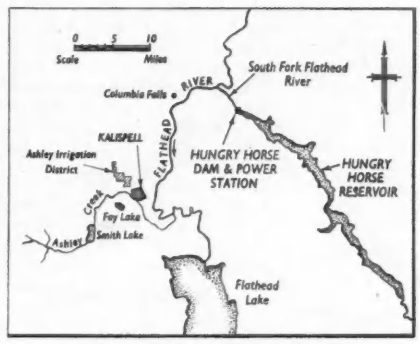
The Hungry Horse dam is situated in an area which is mountainous and heavily timbered and ranges in elevation from 3565ft at the top of the dam to about elevation 9200ft at the headwaters of the south fork. The basin above the dam is 80 to 85 miles long and has a catchment area of approximately 1640 square miles. Annual precipitation in the area ranges from 22in per year at the town of Columbia Falls to about 35in in the mountains. Hungry Horse dam and its power plant constitute a key unit within a comprehensive, long-range programme of development to ensure the full control and utilisation of the Columbia River for agricultural and industrial purposes in the Pacific North-West of the United States. Extensive studies were made by the Bureau of Reclamation in co-operation with the Bonneville Power Administration to determine the economic height of the dam, and the cost of the scheme was balanced against the benefits to be derived from power generated at the power plant. The plan of operation contemplates full capacity power generation during the winter months when power is needed most and water releases can be used to the best advantage downstream. In the spring and summer months, when ample power is available at the downstream power plants, the scheme stores water and generates a minimum amount of power. This plan lends itself ideally to flood control of the Columbia River. Whenever snow surveys and winter climatic data indicate an abnormally high run-off, the reservoir can be lowered early so that it can retain the high water during the flood season. The accompanying table shows the increase in firm power generating capacity at the downstream dams made possible by the construction of the Hungry Horse dam.

Generating Capacity of Columbia River System

Power plants	Without Hungry Horse dam	With Hungry Horse dam
	MW	MW
Bonneville	377	408
The Dalles	517	567
McNary	481	533
Rock Island	199	227
Chief Joseph	594	688
Grand Coulee	1139	1347
Albeni Falls	20	27
Cabinet George	56	100
Thompson Falls	27	49
Kerr	68	145
Hungry Horse	—	197
Totals	3478	4288

Aerial view of completed Hungry Horse dam, power station and reservoir

The Hungry Horse dam is also expected to play an important part in the future Kalispell project which will irrigate 85,000 acres of rich valley soil. Several plans for this project are now under consideration, and the most promising one calls for pumping water from the middle fork of the Flathead River with low-cost power from the Hungry Horse power station.



Map of Hungry Horse project

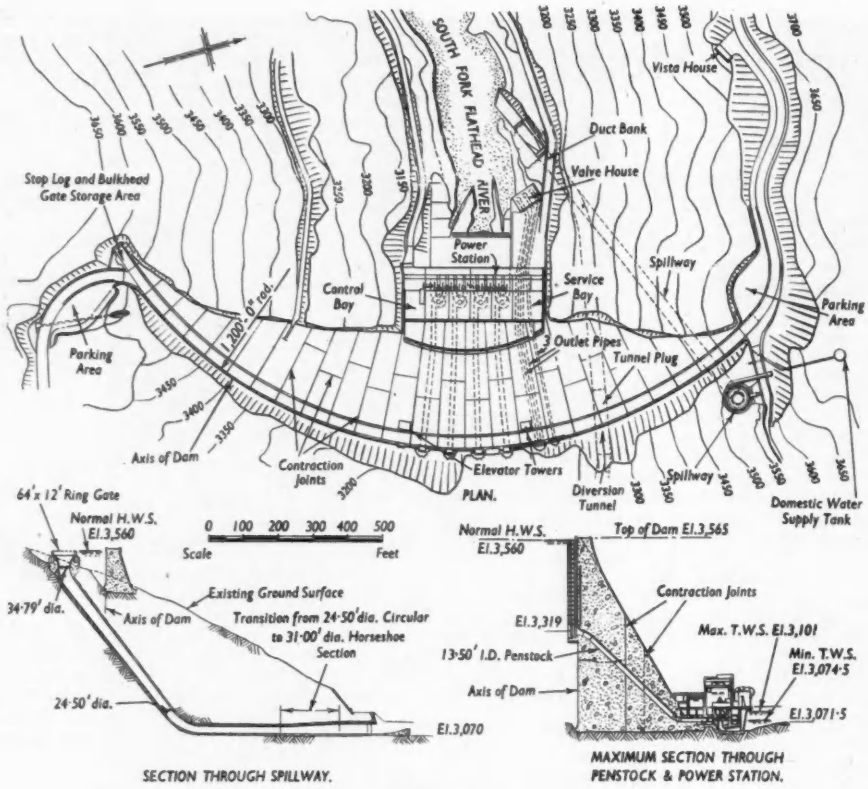
Hungry Horse Reservoir

The Hungry Horse Reservoir is shown in the aerial photograph and the maps reproduced in Figs. herewith. The gross storage capacity of the reservoir is about 3,500,000 acre-feet; 2,980,000 acre-feet of this is active storage to be used for power generation, flood control, and future irrigation needs. When full, the reservoir extends upstream about 35 miles and covers about 24,000 acres. Contracts for clearing the reservoir area were awarded by the Bureau of Reclamation in several amounts totalling over 7,000,000 dollars. An estimated 70,000,000 board-feet of merchantable timber was involved in the reservoir clearing operations and, in order to salvage as much of this as possible, the Government awarded separate logging contracts to precede the clearing operations by about four months. Payment for the removal of the trees was made on a "stumpage basis," the loggers purchasing the timber as it was removed. The money received for this lumber was then applied against the cost of the reservoir clearing.

To facilitate the rapid clearing of the dense forest area, the clearing contractors developed a method which involved some rather unusual equipment. The method depended primarily on a 2in steel cable which was dragged by two heavy tractors to snag and uproot brush and small trees on the steep sides of the reservoir. A 4½-ton hollow steel ball, 8ft in diameter, whose axle was attached by swivels to the middle of the cable, weighed down the cable and supported it at the most effective height. The cable was equipped with swivels every 50ft to prevent twisting and varied in length from 400ft to 800ft. The width of the strip cleared was varied by the tractor operators depending on the size and number of trees between the tractors. About 4000 acres were cleared in this manner and, in some instances, as many as 200 acres were cleared in four hours.

Dam Structure

The Hungry Horse dam is a variable-thickness, concrete arch dam approximately 2100ft long at the crest with a maximum height of 564ft. In height, Hungry Horse dam is exceeded in the United States only by the Hoover dam (726ft) and the Shasta dam (602ft). Containing approximately 2,900,000 cubic yards of concrete, it is exceeded in volume only by the Grand Coulee, Shasta and Hoover dams in the United States. Four 162in diameter penstocks and three 96in



Plan, elevation and sections of Hungry Horse dam and power station

diameter outlet pipes extend through the dam, as illustrated in the drawings reproduced here The penstock entrances on the upstream face of the dam are protected by individual trashracks and can be closed by hydraulic gates. The outlet pipe entrances on the upstream face of the dam are protected by two trashracks and can be closed by a bulkhead gate lowered from the top of the dam. The main design details of the dam and their relative positions are shown in the drawing.

The foundation rock for the dam and its appurtenant structures is Siyeh limestone, which contains appreciable quantities of clay, silica and magnesia. As the foundation for an engineering structure, this rock is considered to be superior to purer limestones because its impurities have somewhat increased its hardness and greatly lessened its solubility. The beds are regular and range in thickness from a few inches to several feet. The foundation rock is cut by one major and several minor shear zones and by one major bedding-plane slip. The clayey material in the bedding-plane seam was washed out by drilling vertical holes in a suitable pattern, and was replaced with grout. The major shear zone, ranging from 8ft to 20ft in width in the foundation area, strikes north-east across the dam foundation and dips steeply toward the south-east. This zone was sealed effectively by cut-off shafts at the upstream and downstream toes of the dam. The shafts were washed with high-pressure air and water, backfilled with concrete, and sealed by high-pressure cement grout.

The lay-out of the required foundation excavation specified that the contours of excavation be on radial lines as far as practicable and economical to obtain. All the bedding planes have the same dip. Besides dipping steeply from left to right, they also dip slightly in an upstream direction. For this reason it was necessary to cut through the strata between bedding planes parallel with the axis of the dam on the left abutment to obtain uniform radial foundation contours.

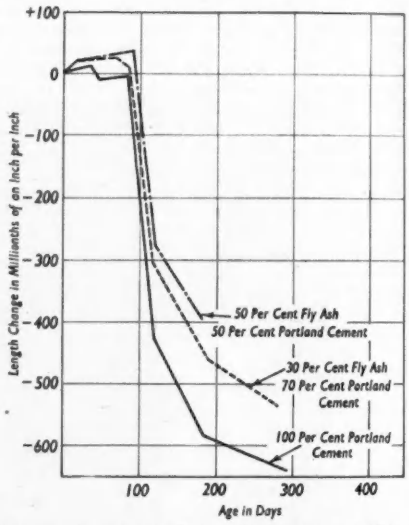
The Hungry Horse dam was designed as a variable-thickness structure having a vertical upstream face and half radial abutments. The cantilevers, or vertical radial elements of the structure, carry a large part of the load as the canyon is V-shaped and has rather flat slopes on each side. The upstream face was made vertical to take full advantage of the dead weight in reducing cantilever stresses when the reservoir is full. The variable thickness layout was chosen to give a better distribution of stress and economy in concrete volume and the abutments were made half-radial so that the resultants at the arch abutments would cross the excavation contours at an angle as near 90 deg. as possible to give maximum stability without excessive rock excavation.

The dam was designed by the trial-load method. The analysis included the following loading conditions :—(1) reservoir water surface at elevation 3560ft ; (2) a 2ft 6in thick ice sheet exerting a pressure of 10,000 lb per lineal foot, and (3) earthquake acceleration acting upstream along the line of centres with an intensity of 0·1 that of gravity. The maximum computed compressive principal stress was found to be 731 lb per square inch and occurred at the downstream left abutment at elevation 3200ft. The maximum computed tensile principal stress was 30 lb per square inch, occurring at the upstream right abutment at elevation 3450ft.

A division of the mass concrete into blocks by vertical contraction joints was necessary because of the size of the dam. The transverse or radial joints were continuous from the upstream to the downstream face and spaced at 80ft intervals on the upstream face of the dam. As the base thickness of the dam was over 320ft, one longitudinal joint was placed in the longer blocks to prevent the development of continuous, wide cracks across the blocks. The longitudinal joint was offset in adjacent blocks and placed so that the longest single block would be 186ft. The vertical contraction joints thus divide the dam into blocks, the largest of which is 80ft by 186ft and contains about 3700 cubic yards of concrete in each 5ft lift. To ensure the monolithic action of the structure, the contraction joints were filled with cement grout under pressure through a system of piping after the concrete was cooled to the desired minimum temperature of 38 deg. Fah. To obtain the desired temperature and joint openings during the construction period, it was necessary to cool the concrete by means of an embedded pipe system through which river water was circulated. This artificial cooling system was then used, at a very slight increase in cost, to control cracking by lowering the temperature rise of the concrete during the early age. This, in turn, permitted a wider spacing of the contraction joints than would otherwise have been permissible. The cooling system consisted of 1in diameter thin-wall steel tubing space 3ft to 5ft 6in horizontally and placed on the foundation rock and on the top of each 5ft lift of concrete. No special measures for cooling the aggregate, sand, cement, or water were thus required. Cooling the concrete and grouting the contraction joints was applied progressively as the level of construction rose, with the contraction joints being grouted as soon as possible after each initial cooling stage was completed.

One of the most extensive laboratory investigations ever undertaken by the Bureau of Reclamation laboratories for a single project covered the studies of the concrete to be placed in the Hungry Horse dam. These investigations included analyses of the concrete mix, compressive strength and elastic properties, heat of hydration, thermal properties, volume change, permeability and durability. Over 1000 concrete cylinders and bars were tested and analysed during this work. As a result of this comprehensive laboratory undertaking, which corroborated studies made by others, 130,000 tons of fly ash were used in the manufacture of the 2,900,000 cubic yards of mass concrete for the dam. Its use has resulted in the following advantages :—A saving in Portland cement in a region where there is a scarcity ; a reduction in the cost of the structure due to the lower cost of the fly ash as compared with Portland cement ; an improved workability of the concrete ; less segregation and bleeding ; a lower heat of hydration, and a greater impermeability.

The tests indicated that the early strength of concrete is reduced in proportion to the amount of fly ash substituted for Portland cement, but that concrete containing fly ash gains strength



Measurements made on 4in × 4in × 30 beams, fog cured 90 days then dried at 50 per cent humidity, 70 deg. F.

Effect of fly ash content in concrete on drying shrinkage

more rapidly than that without fly ash, except at early ages. After a period of about one year, the strength of concrete containing 30 per cent of fly ash is about the same as that of concrete containing no fly ash. The tests also disclosed that fly ash does not contribute to autogenous shrinkage. This property is extremely important in planning the block grouting programme to determine the age at which the greatest shrinkage occurs, and in evaluating the equivalent temperature stresses occurring within the mass. It was found that concrete containing fly ash has slightly higher thermal coefficients of expansion than that without fly ash. Furthermore, the presence of fly ash tends to decrease the drying shrinkage as illustrated above.

(*To be continued*)

Industrial and Labour Notes

Coal Price Increase

At the end of last week the National Coal Board announced that the present inland prices of all its coals would be increased by 18 per cent, which represents an average of 11s. 5d. a ton, as from Monday next, July 18th. In making this announcement, the Board stated that its financial position was such that, allowing for all practical economies in its operations, a substantial price increase was necessary to bring prospective expenditure and income into proper relation. The price increases, it was explained, would yield £53,000,000 this year and £118,000,000 in a full year.

But, the Coal Board said, these increases were not such as to secure a reduction in the accumulated deficit (at present £17,400,000) by the end of 1956 ; by the end of this year it was expected to rise by £15,000,000, not all of which was expected to be made good in 1956. The two Consumers' Councils and other bodies concerned with coal consumers' interests have been furnished by the Board with an explanation of its financial position and of the considerations which have led to the decision to increase coal prices. This explanation of the Board's main financial commitments says that wages in the coal industry, which represent over 60 per cent of production costs, must be related to the general level of wages in the country, which has increased substantially and is still rising. It goes on to point out that heavy additional expenditure on safety and health measures will be required this year and next, and that reconstruction costs are increasing. Other increases in production costs which are impending are increased National Health contributions and local rates ; social welfare costs, which can no longer be financed from funds handed over by the Miners' Welfare Commission ; research and development both for improving mining methods and for smokeless fuels, and greater expenditure on education and training. In addition, there is the much bigger expenditure on imported coal. The average delivered price of imported coal is now more than £2 a ton above the present selling price of similar qualities of British coal. In 1954 the loss on this account was £5,029,258; this year, it is stated, it is likely to be five times as much.

The increase of 18 per cent will apply to the existing prices of all coals supplied for inland consumption. Examples of the actual increase per ton which various consumers have to bear include : gasworks, 12s. 5d.; power stations, 9s. 3d.; railways, 12s. 5d.; coking plants, 11s. 8d. or 12s.; iron and steel works, 11s. 6d.; coastwise bunkers, 12s. 9d.

Coal Supplies and Prices

The National Coal Board's announcement about coal price increases has understandably drawn comment from a number of trade associations and other organisations representative of consumer interests. Among them is the Association of British Chambers of Commerce, which has submitted a memorandum on the price and supply of coal to the chairman of the National Coal Board and to the Minister of Fuel and Power. This memorandum comments on " the unprecedented increase in price of such an important basic raw material," and expresses the view that for the Coal Board to impose, and the Government to approve, such an increase at the present time is not in the national economic interest.

The Association asks that the National Coal Board should undertake a re-examination of the present programme of capital development and reconstruction, and puts forward a " five-point plan " aimed at taking coal out of a sellers' market and lessening the nation's dependence upon it. The Association's plan includes the acceleration of coal to oil conversion throughout industry, wherever it is possible. Other points in the Association's plan are that wages in the coal mining industry should, in future, be strictly related to output ; and that a proportion of the present planned capital investment in the coal industry might be utilised for advancing and accelerating the development of atomic energy and research into the use of new forms of fuels for industrial purposes. Furthermore, it is suggested that the exporting of British coal (other than to bunkers) should cease at the earliest practicable moment, until the prior claims of British industry can be met substantially from home produced coal. As a corollary, the memorandum adds here, the importing of coal should be reduced " to the minimum necessary."

Railway Wages

Another railway wage claim is foreshadowed by the terms of a resolution which was passed last Friday at the annual conference of the National Union of Railwaymen. A statement issued by the N.U.R. gave details of the resolution, which said that all N.U.R. members employed by the British Transport Commission were still inadequately paid, and that the real cost of living was still increasing. Bearing these two factors in mind, the conference instructed the union's national executive to formulate a wage claim on behalf of all N.U.R. members, and to present it for negotiation as speedily as possible. It was resolved that the claim should be agreed jointly, if possible, " with the unions concerned," but, failing agreement with those bodies, that it should be presented by the National Union of Railwaymen.

Overseas Trade

According to provisional figures from the Board of Trade, the value of recorded exports of United Kingdom goods in June was £157,000,000, which was £90,000,000 below the average for the two months April and May. The drop in June brought the average monthly rate of export for the second quarter of this year to 12 per cent below the average for the first quarter.

Recorded imports in June were valued at £293,900,000, which was only 3 per cent below the average for April and May. But the average monthly rate of imports for the whole of the second quarter of this year was 10 per cent below the average for the first quarter. On the other hand, total imports in the first six months of this year were 14 per cent higher than in the comparable period of 1954. Re-exports in June were valued at £8,100,000. The excess of imports over total exports was therefore £128,800,000 in June, compared with an average of £47,900,000 a month in April and May, and £77,100,000 a month in the first quarter of this year.

The Board of Trade says that the extent to which imports and exports were affected in June by the railway and dock strikes cannot be assessed. The figures for the next few months will undoubtedly continue to show the effect of the dock strike.

Employment and Unemployment

The Ministry of Labour's report on the employment situation in Great Britain at the end of May states that, during the month, the working population increased by 13,000 to a total of 23,849,000. Of the total, 22,852,000 (15,135,000 men and 7,717,000 women) were in civil employment.

The Ministry's analysis of the civil employment figures shows that during May there was an addition of 19,000 to the labour forces of the basic industries. The increases were seasonal ones in transport and agriculture. In the coal mining industry, the manpower total dropped by 3000 to 706,000. In the manufacturing industries, the total number of people employed at the end of May—9,233,000—was the same as a month earlier, additions in the engineering and vehicle building groups being offset by losses in the textile and clothing trades. In the engineering industry, the labour force increased during May by 7000 to 2,765,000, and in vehicle building there was an addition of 4000, bringing the number employed at the end of the month to 1,234,000.

About unemployment, the Ministry of Labour says that on June 13th there were 210,543 people registered as out of work, a figure which included 30,026 described as temporarily stopped. The number of unemployed was 13,000 less than that returned on May 16th and represented 1 per cent of the total number of employees. The Ministry says also that, in the week ended May 28th, about 1,580,000 employees in manufacturing establishments were working, on an average, eight hours' overtime. This was 40,000 less than in February, but 80,000 more than a year earlier. In the same week, 59,000 operatives were reported to be on short time, losing fourteen hours each on the average.

Northern Ireland's Industrial Production

The report on the 1953 census of industrial production in Northern Ireland shows that the total gross output in that year amounted to almost £351,000,000, compared with £320,268,000 in 1951. It is also stated that between the last pre-war census of 1935 and that of 1953 there was an increase of 50 per cent in employment in Northern Ireland. The report says that customers in Great Britain took nearly 48 per cent of Northern Ireland's industrial production in 1953, 41 per cent went to " home " customers, and the remaining 11 per cent was exported to countries outside the United Kingdom. The proportion of overseas exports going to Commonwealth and foreign countries was 40 per cent and 60 per cent respectively, by far the largest overseas market for Northern Ireland being the U.S.A., where goods to the value of £7,500,000 were sold in 1953.

Strikes and Steel Production

The British Iron and Steel Federation has stated in the latest issue of its *Monthly Statistical Bulletin* that the industry's production record for the first half of the year has been somewhat marred by the rail and dock strikes. The output of steel ingots and castings, which had been above last year's level every week until the end of May, dropped back in June. The total for the first five months, at 8,254,000 tons, was 8 per cent higher than in the comparable period of last year, but the June figure is likely to be much the same as in June last year. Nevertheless, the Federation says, steel output for the first half of this year is likely to be about 6 per cent above the 9,524,000 tons produced in January to June, 1954.

The *Bulletin* points out that the iron and steel industry is very dependent upon rail transport. The blast-furnaces consume over 500,000 tons of ore and 250,000 tons of coke a week, as well as other materials, and the steel works absorb some 30,000 tons of pig iron and bought scrap weekly, as well as large tonnages of coal and oil. Nearly all this material; as well as about three-quarters of the weekly output of 280,000 tons of finished steel, is normally delivered by rail. But, on the whole, the Federation states, the effect of the rail and dock strikes so far apparent has been less serious than might have been expected. This is due partly to the substantial stocks of raw materials carried by the industry, and partly to remarkably effective improvisations which were put into operation in the transport departments and elsewhere. The effects of the strikes have varied from works to works and even from department to department, with the result, the *Bulletin* comments, that generalisation may be misleading. Broadly, however, it can be said that the coke ovens and blast-furnaces were affected more than the melting shops and the latter more than the mills.

Personal and Business

Appointments

HON. MICHAEL LAYTON has been appointed assistant to the joint managing directors of Guest Keen Iron and Steel Company, Ltd.

MR. STANLEY S. DAWES, M.I.Mech.E., has been re-elected president of the Institute of the Motor Industry, for the ninth successive year.

DR. P. DUNSHEATH, M.I.E.E., has been elected president of the International Electrotechnical Commission, in succession to Dr. H. S. Osborne, of the U.S.A.

THE MINISTRY OF SUPPLY announces the appointment of Dr. R. Cockburn as deputy controller of electronics, in succession to Rear-Admiral G. Burghard.

MR. J. R. DAVIES, Simonsmede, Green Hill, Evesham, Worcs, has been appointed Midland area manager of Newall Group Sales, Ltd., Old Fletton, Peterborough.

BRITISH OXYGEN COMPANY, Ltd., states that Air Vice-Marshal D. V. Carnegie has been appointed to carry out, on its behalf, liaison duties with the armed Forces and Government departments.

MR. D. F. BAXTER has been elected chairman of Baxter, Fell and Co., Ltd., Ibex House, Minories, London, E.C.3, in succession to Mr. C. B. Hewitt. Mr. Hewitt continues as a director of the company.

MR. J. O. BLAIR-CUNYNGHAME has been appointed director-general of the staff department of the National Coal Board. He has been chief personnel officer of British Overseas Airways Corporation since 1947.

LIEUT.-COLONEL S. M. LOVELL, county surveyor of the West Riding of Yorkshire, has been elected president of the Institution of Highway Engineers, in succession to Mr. R. B. Carnegie, who has held the office for two years.

THE BRITISH TRANSPORT COMMISSION announces the appointment of Mr. J. F. Connor as mechanical and electrical engineer, Fleetwood, British Transport Docks. Mr. Connor has been engineering assistant (mechanical), N.W. Division, British Transport Waterways.

THE BRISTOL AEROPLANE COMPANY, Ltd., announces the following appointments in its engine division :—Dr. E. J. Warlow-Davies, deputy chief engineer and a member of the divisional board ; Mr. S. S. Tresilian, assistant chief engineer ; Mr. B. S. Massey, assistant chief designer ; Mr. B. D. Blackwell, engineer-in-charge of a new department for the development of turbine blades.

DAVID BROWN TRACTORS (ENGINEERING), Ltd., Meltham, Huddersfield, announces the appointment of Mr. J. C. R. Birney as assistant general manager. Mr. T. A. Lazenby has been appointed agricultural sales manager, Mr. C. F. Ward has been appointed home sales manager, and Mr. R. W. Ladbrooke continues in charge of the sales of industrial tractors and ancillary equipment.

VACUUM OIL COMPANY, Ltd., announces the following appointments :—Mr. G. A. Dickins, assistant manager of the technical department at the London headquarters ; Mr. V. H. Rumble, superintendent of the Wandsworth central laboratories ; Mr. F. J. Patman and Mr. P. E. B. Vaile, assistant supervisors of the products division. Mr. T. Paterson formerly supervisor of the lubricant and allied products section at the central laboratories, has been transferred to the headquarters office, where he will be responsible for matters concerning greases, patents and industrial hazards.

FOUNDRY SERVICES, Ltd., Long Acre, Nechells, Birmingham, announces the following appointments : Mr. R. D. Hume, deputy managing director and works director ; Mr. R. A. Miller, director and sales manager ; Mr. G. E. Cobby, director and chief accountant ; Dr. D. V. Atterton, technical manager, and Mr. R. F. Boddey, deputy technical manager. Mr. R. A. Miller has been appointed a director, Mr. G. E. Cobby, secretary, and Mr. D. A. J. Patterson, overseas manufacturing and export sales manager of Foundry Services (Overseas), Ltd. Dr. K. Strauss continues as chairman, and Mr. E. Weiss, as managing director of both companies.

Business Announcements

W. AND H. NELSON, Ltd., Mossend, Lanarkshire, has appointed British Flottman Drill Company, Ltd., Cardiff, as its agent in South Wales.

C. H. JOHNSON (MACHINERY), Ltd., Stockport, has been appointed sole selling agent in Great Britain and Northern Ireland for the concreting equipment manufactured by Allgemeine Maschinen-Gesellschaft (A.B.G.).

VAUXHALL MOTORS, Ltd., Luton, states that it is doubling the size of its education and training centre in order to increase the intake of apprentices to 125 a year.

DUNFORD AND ELLIOTT (SHEFFIELD), Ltd., states that the department now operating from Linford Street, London, S.W.8, is to be formed into a subsidiary company entitled Dunford and Elliott Process Engineering, Ltd.

W. G. BAGNALL, Ltd., Stafford, has made an agreement with Morrison and Bearby, Ltd., Newcastle, New South Wales, covering the manufacture in Australia of diesel mechanical shunting locomotives to Bagnall designs.

THE BRISTOL AEROPLANE COMPANY, Ltd., has formed a subsidiary to take charge of its sales activities in New Zealand. It will be known as the Bristol Aeroplane Company (New Zealand), Ltd., its offices being situated in Wellington.

THE CONISTON COMPANY, Ltd., has been formed to carry out the design of heavy projects and process plants. Mr. L. J. Schwarz is the chairman and managing director. The company's address is Eagle House, High Street, Wimbledon, London, S.W.19 (telephone, Wimbledon 1191).

THE SHEFFIELD TWIST DRILL AND STEEL COMPANY, Ltd., Summerfield Street, Sheffield, has acquired the whole of the issued share capital of Accurate Screw Threads, Ltd., Hednesford, Staffs. Mr. H. Morris continues as managing director of the latter company and Mr. W. T. Brooks has been appointed production manager.

TELECABLES AND WIRES, Ltd., is the name of a manufacturing company recently formed in Canada by Canada Wire and Cable Company, Ltd., General Cable Corporation of New York, and the Telegraph Construction and Maintenance Company, Ltd. The new company is to erect a telephone wire and cable-making plant at Fort Garry, Winnipeg.

THE TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, Ltd., states that it has acquired the whole of the undertaking of Magnetic and Electrical Alloys, Ltd., Burnbank, Scotland. Mr. J. Ancel Holden continues as chairman of the latter company, and Mr. W. F. Randall, a director of the Telegraph Construction and Maintenance Company, Ltd., has been appointed vice-chairman and managing director.

Contracts

D.M.M. (MACHINERY), Ltd., has received an order on behalf of Lurgi-Gesellschaft fur Chemie und Huttenwesen, for four Lurgi-Frodingham sinter coolers. This order, valued at £189,000, has been placed by the Appleby-Frodingham branch of the United Steel Companies, Ltd.

JOHN LAING AND SONS (CANADA), Ltd., a newly established branch of the British parent company, has been awarded a contract valued at 6,000,000 dollars for the construction of a twenty-one-storey office building for the B.C. Electric organisation, in Vancouver, British Columbia. The building will take about twenty months to construct, and will be the largest building in Western Canada.

THE GENERAL ELECTRIC COMPANY, Ltd., is supplying the General Post Office with equipment for two new television links which will extend the coverage of the I.T.A. transmissions. The first of these is a microwave radio link between Birmingham and Lichfield, which will provide two channels from Birmingham to Lichfield and one channel in the reverse direction. The G.E.C. is providing all equipment for this link, which is similar to the links supplied by the company for the Eurovision network. The second link is from Birmingham to Winter Hill, near Bolton. The G.E.C. is supplying all the line equipment needed for the transmission of I.T.A. signals over a coaxial cable link between these points.

THE BRITISH THOMSON-HOUSTON COMPANY LTD. has received orders through the Australian General Electric (Pty.), Ltd., for turbo-alternators, transformers and switchgear for the new Wallerawang power station of the Electricity Commission of New South Wales. Four B.T.H. 30MW single-cylinder turbo-alternators, with "Magnestat" voltage regulators, are at present on order ; while the transformers include four 32·5MVA, 11/132kV generator units and two 10MVA, 132/3·3kV interconnector units, all with on-load tap changing gear. In addition, five 4MVA, 11/3·3kV and eleven 1000kVA, 3300/415V transformers are being supplied. The switchgear includes eleven 132kV, 2500MVA oil circuit breakers, seven of which have already been completed at the B.T.H. Willesden works ; and ten 66kV, 1000MVA "OW407" units. Five of these "OW407" units have been built and manufacture is going ahead on the 3·3kV Class "AL" air-break auxiliary switchboards and the control and relay panels for the whole station.

Miscellanea

SIR CHARLES TENNYSON, secretary of the Dunlop Company for twenty years, has been awarded the Royal Society of Arts Bicentenary Medal for 1955 in acknowledgment of his services to the promotion of industrial design.

LITTLE BARFORD "B" POWER STATION.—The Central Electricity Authority has received the consent of the Minister of Fuel and Power to the extension of the Little Barford power station, near St. Neots, by the establishment of a new section to be known as Little Barford "B." The present station has two sets with a total installed capacity of 120MW. The extension will add two more 60MW turbo-generator sets and two boiler units each having an evaporative capacity of 550,000 lb per hour of steam.

INTERNATIONAL CONGRESS ON DOCUMENTATION OF APPLIED CHEMISTRY.—An international congress on the documentation of applied chemistry is to be held, under the presidency of Lord Cherwell, at the Institut Francais du Royaume-Uni, Queensberry Place, London, S.W.7, in the latter part of November. There will be technical sessions on Wednesday, Thursday and Friday, November 23rd–25th, various social functions, and an exhibition of books and periodicals and of documentation of applied chemistry as a service for industry.

SIR ALEXANDER ROGER SCHOLARSHIP.—A travelling scholarship has been instituted by British Insulated Callender's Cables, Ltd., as a tribute to Sir Alexander Roger, for many years chairman of the company and now its first honorary president. It will be known as the Sir Alexander Roger travelling scholarship. The scholarship is to have a value up to £1000 in addition to normal emoluments, and will be awarded annually to an employee of the parent company or of one of the various companies in the group. It will enable a young man or woman of ability to travel overseas for study, training and general education for a period of not more than twelve months.

RHUDDLAN BRIDGE.—Rhuddlan Bridge over the river Clwyd in Flintshire, together with the bridge approaches, is to be widened at a cost of about £41,000, the Minister of Transport and Civil Aviation states. Work will begin shortly. Rhuddlan Bridge is scheduled as an ancient monument. The western arch was probably built in 1595 at the same time as the central pier, and the eastern arch, built early last century, probably replaced two similar arches of an earlier bridge. Under the widening scheme care will be taken to safeguard the structure and to ensure that the new work will conform with its present style. Existing stonework, including the face-work of the upstream cutwater, will be used as far as possible. It is expected that the work will take 15 months.

CERTIFICATE OF AIRWORTHINESS INVESTIGATION.—The Air Registration Board has published its eighteenth annual report which covers the year ended March 31, 1955. It states that, during the period reviewed, there were no major aircraft types to reach the certification stage, the Westland S.55 being the only prototype of note. It is added that although the Board's investigation into the airworthiness of prototypes, major modifications and radio installations has followed its normal pattern and there are no special matters on which to report, the importance of the work should not be overlooked as it provides the machinery through which all the other work is made effective. About flight testing, the report says that "the fact that some 125 aircraft were tested by the Board during the year gives some indication of the activity of the department."

BRITISH RAILWAYS' CIVIL ENGINEERING TRAINING.—The North Eastern Region of British Railways states that, in connection with the modernisation plan, a building is now being erected at York specially for the technical and other staff who will plan, design and supervise the carrying out of a big volume of civil engineering work. In conjunction with a special instruction school, it will now be possible for the chief civil engineer of the Region to take in more graduate and student civil engineers from universities, colleges and schools for training as railway civil engineers. It is emphasised that railway civil engineering covers a very wide field, not only giving opportunities for specialisation in planning, design and supervision of new works, bridges, or permanent way, but also for investigating, studying and organising a variety of maintenance and construction works.

S.M.M.T. STANDARDS.—The council of the Society of Motor Manufacturers and Traders, Ltd., announces the formation of a reorganised and enlarged standards department. This department will work under the direction of a Standards Board, composed of senior executives from the car, and light, medium and heavy commercial vehicle manufacturers, and the chairmen of each of the existing standards committees of the Society. Invitations will also be extended to senior executives from companies supplying main component parts to the motor industry. The nucleus of the first Standards Board has now been formed under the chairmanship of Mr. E. G. Grinham, deputy managing director of the Standard Motor Company, Ltd., and consists of the members of the steering committee which recently investigated standardisation problems. The main categories of standardisation to be covered by Standards Board, are dimensional standards ; material and qualitative standards ; safety and performance standards with particular reference to regulations and legislation, and technical and test procedure standards. Mr. Eric Woodbridge has been appointed manager of the standards department. It is stated that the Standards Board will work in close co-operation not only with the existing S.M.M.T. technical committees, but also with national and international organisations covering a similar but more general function.

British Patent Specifications

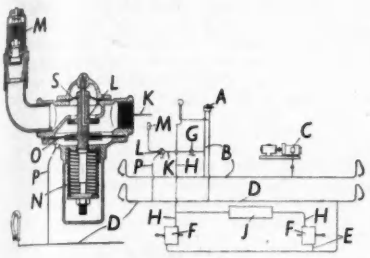
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

RAILWAY ENGINEERING

732,031. October 15, 1953.—VACUUM BRAKE APPARATUS, Gresham and Craven, Limited, Ordsall Lane, Salford, 5, Lancashire. (*Inventor: Gerald Cranton Marsh.*)

The invention relates to vacuum brake apparatus for railway and like vehicles and its object is to provide effective means whereby the brakes on the locomotive can have their power augmented or whereby smaller brake cylinders can be used without any reduction in the brake power available. The drawing shows a vacuum brake system arranged in



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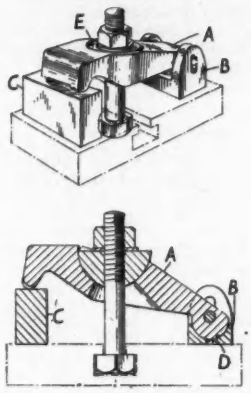
accordance with the invention. The usual brake valve *A* controls the connection between the pipe *B* leading to the exhauster *C* and the train pipe *D* which has the usual connection *E* to the locomotive brake cylinders *F* containing the pistons which apply and release the brakes. The pipe *B* has connections via the non-return valve *G* with the pipe *H* which leads to the vacuum chamber *J* and to the vacuum side of each locomotive brake piston in its cylinder *F*. The pipe *B* also has a connection *K* via the automatic isolating valve *L* to the vacuum relief valve *M*. The pipe *B* runs from end to end of the locomotive. The automatic isolating valve *L* is normally held in the open position by a spring *N*. The diaphragm *O* has at one side the pressure in the pipe *K* and at the other side the pressure in the train pipe applied via the pipe *P*. Under normal running conditions, these pressures are equal and so the valve *L* is held open and communication is established between the pipe *K* and the vacuum relief valve *M*. This prevents the vacuum rising unduly, say above 20in to 21in mercury, by admitting air to the system. When a normal service brake application is made, vacuum is maintained above the diaphragm *O* by the exhauster at the normal figure of say 20in to 21in mercury as determined by the relief valve *M*. Air from the train pipe connection *P* passes to the underside of the diaphragm *O*, but the isolating valve *L* remains open unless the train pipe vacuum falls unduly, due to a heavy or emergency brake application, when the train pipe vacuum may fall below 5in mercury. Then the pressure on the lower side of the diaphragm *O* is able to overcome the pressure of the spring *N* so that the valve *L* shuts, so isolating the relief valve *M* from the exhauster pipe *K*. The exhauster can now raise the vacuum in the pipe *H* and so at the vacuum side of the pistons in the locomotive brake cylinders *F*, giving augmented locomotive brake power for heavy or emergency brake applications. When the brakes are released by appropriate operation of the valve *A*, and the vacuum in the train pipe *D* and in the space below the diaphragm *O* are restored and are at about 8in mercury, the isolating valve *L* is opened, thus allowing the vacuum relief valve *M* immediately to reduce the high vacuum at the vacuum side of the locomotive brake pistons to a normal figure. This ensures that the final release of the brakes on both locomotive and train is synchronised. With the improvement the maximum pressure on the locomotive braking pistons can be raised by 50 per cent over the normal figure. The vacuum producing unit may be a steam ejector on a steam locomotive. As shown, an independently motor-driven rotary exhauster *C* is employed.—*June* 15, 1955.

TOOLS AND WORKSHOP APPLIANCES

732,303. MAY 22, 1953.—WORK-HOLDING CLAMPS, Emile William Harold Stanleigh, Killowen Street, Coleraine, Northern Ireland.

The clamp, as shown in the drawing, is specially designed for holding irregularly-shaped workpieces or pieces with inclined surfaces. The clamping member *A* is carried at its back end by a support *B* and its front end bears down on a workpiece *C* on the work-table. The front end of the clamp piece has a rounded nose with two bearing portions. The back end has a spherical convex projection *D* which rests in a corresponding depression on the support *B*. The support has two upright arms in which the clamping member can tilt freely about its trunnion axis, while remaining firmly supported. It can also



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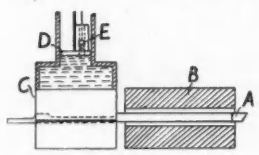
tilt about a longitudinal axis within the limits permitted by the trunnion pins in slots in the arms. Intermediate between the nose and the supported end of the clamp piece is a substantially hemispherical depression with a hemispherical washer *E*, through which a holding-down bolt passes. When in use the head of the bolt is fitted in a tee-slot in the work-table, as shown, and the clamping member can be tightened by screwing down the nut.—*June* 22, 1955.

731,726. January 14, 1953.—SHAPING METAL BY THE APPLICATION OF PRESSURE, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor: Kenneth Robert Hopkirk.*)

The invention relates to the controlled shaping of metals by application of pressure to give them a desired form. In the drawing *A* is the steel rod having a cross-section corresponding substantially to the greatest cross-section of a finished turbine



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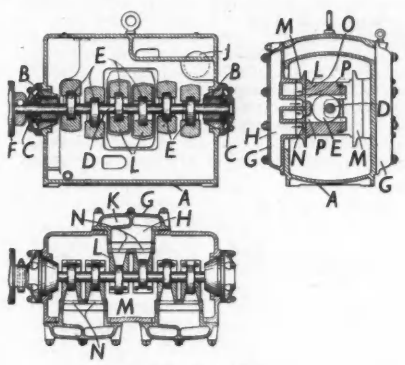
blade. The rod is passed through a furnace *B* in which it is heated by induction to the required temperature. It then passes into a hydraulic press *C*, in which it is subjected to a constant pressure by means of the piston *D* and to an alternating component pressure through the auxiliary piston *E* which is reciprocated either mechanically or electrically. This alternating component, it will be understood, is small compared to the constant pressure. By subjecting the metal to the two pressures as described it has been found that the time taken to press the required shape is much reduced. In some cases the metal being shaped may fall below the temperature required for pressing before it is completely formed, and means may, therefore, be provided for withdrawing the rod *A* into the furnace to be reheated. This may be done at predetermined regular intervals, or at intervals determined by the temperature of the metal.—*June* 15, 1955.

PUMPS

732,167. March 24, 1953.—ROTARY PUMPS OR COMPRESSORS, Megator Pumps and Compressors, Ltd., 43, Berkeley Square, London, W.1, and Frederick Walter McCombie, of the company's address.

The invention relates to rotary pumps of the non-centrifugal type, examples of such pumps forming the subject of prior specifications Nos. 592,432, 617,750, 622,792 and 639,017. The invention is described in detail as applied to a pump which includes three pairs of shoes. In the construction shown in the drawing the pump comprises a body or casing *A* carrying at its ends bearings *B* and seals *C* for a rotor shaft *D* carrying eccentric discs *E*, the rotor shaft carrying a coupling drum *F* through the medium of which the rotor shaft is driven from a suitable source of power supply. The body carries three main covers *G* forming suction chambers *H* which communicate with a common inlet *J*. The three main covers *G* are also formed with discharge passageways *K* which communicate with the main body of the pump, the pressure in the interior of the pump being higher than at the suction side. Each disc *E* revolves in a shoe *L* which is composed of a natural or synthetic rubber or incorporates a lining of such material, the shoe fitting the disc on its opposite faces and also at two opposite points on its periphery. The arrangement is such that as a result of rotation of the disc the shoe will be reciprocated vertically over the face of a port plate *M* carried by the adjacent cover *G*. Each port plate is formed with two sets of laterally spaced suction and discharge ports, one set being provided for each shoe, there being in each set two suction ports *N* which communicate with the interior of the cover *G* and two discharge ports *O* which lead to the interior of the main body of the pump. The pressure being higher in the interior of the pump body than in the ports *N* and covers *G*, tends to hold all the shoes in good sealing engagement with the faces of the port plates. Each shoe is formed with a pair of ports *P* which perform the functions of both suction and discharge ports and communicate alternately with ports



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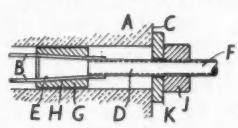
N and *O* under the reciprocating action of the shoe. The effective internal volume of the shoe is varied as a result of rotation of the disc and consequently the shoe acts as a displacement chamber, the liquid being drawn into the interior of the shoe through the ports *N* and when ports *O* and *P* are in register being discharged through ports *O* and into the interior of the pump body from which it is finally discharged. The two discs of the centre pair are arranged at 180 deg. to one another, the two discs at each outer pair being also at 180 deg. to one another and the outer pairs at 120 deg. and 240 deg., respectively, to the centre pair. This places the six discs in equally-spaced angular positions with their working strokes occurring in regular sequence and results in a smooth displacement of fluid and an even turning moment. This arrangement of six shoes has another advantage over the commonly used design employing three shoes, namely, that there are two shoes functioning at every point in the cycle, whereas with three shoes at 120 deg., although the theoretical combined displacement curve is practically as smooth as with the six shoes, it is the resultant of two shoes functioning during parts of the cycle and only one shoe during other parts. The actual displacement of the fluid is equivalent to the theoretical combined displacement of the shoes less the leakage or slip, and this leakage is twice as great when two shoes are functioning as when one only is functioning. Thus, the three-shoe pump introduces in practice an irregularity of flow that is absent from the six-shoe pump in which there are always two shoes functioning at one time.—*June* 22, 1955.

CIVIL ENGINEERING

732,469. December 18, 1952.—PRESTRESSING CONCRETE, Alexander Mantscheff, 9, Hermann-Lönsstrasse, Rodenkirchen, near Cologne, Germany.

One form of apparatus for prestressing concrete is shown in the drawing. The apparatus is intended for prestressing a concrete construction *A* and by its use the tensile forces in the stressing members or



No. 732,469

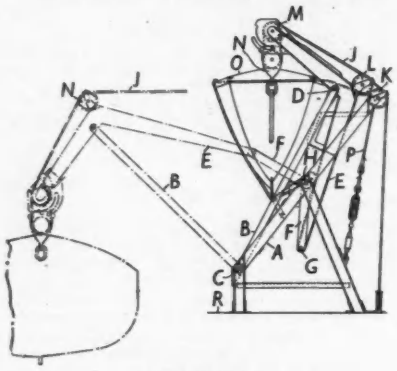
wires *B* are transmitted to the end face *C* by means of a tie bolt *D*. The tie bolt has a conical part *E* at its inner end. The prestressing wires *B* extend longitudinally through a sleeve *G* and are gripped in position against the internal wall *H* of the sleeve by the part *E*. The bore of the sleeve is also of conical

form and is a push-fit on the part *E*. On the building site, the prepared clusters of prestressing wires are arranged in position. When the concrete has set, the prestressed wires are all simultaneously initially tensioned, as required by means of apparatus, such as hydraulic presses. For this purpose the shank *F* of each tie bolt *D* is threaded for connection to the hydraulic press. The wires are held in the tensioned position by tightening the anchor nuts *J* of the tie bolts. The anchor nuts bear against the anchor plates *K* and the face *C* to anchor the stressing members *B* relatively to the concrete. The use of this method and apparatus ensures that all the prestressing wires are substantially uniformly loaded.—*June* 22, 1955.

MARINE ENGINEERING

732,219. December 12, 1953.—SHIP'S DAVIT, Mechans, Ltd., Scotstoun Ironworks, Glasgow, W.4 ; and John Martin Binmore, "Westering," Rougemont Avenue, Cadewell, Torquay, Devon.

In the ship's davit shown in the drawing, *A* is a fixed bracket consisting of two spaced parallel structures, *B* is a radius rod pivoted at one end at *C* to the bracket and at the other end at *D* to a davit arm *E* between the ends of the davit arm. A second radius rod *F* is pivoted at one end at *G* to the inboard end of the davit arm *E* and pivoted at the other end at *H* to the bracket *A*, the pivot being at a higher level than the pivot *C*. The falls *J* are led along pulleys *K*, *L* and *M* to a pulley block *N* connectible to a lifeboat *O*, the pulley block *N* in the same plane as the davit arm *E*. A cable *P* encircles the lifeboat when it is in the inboard position to hold it against accidental movement.



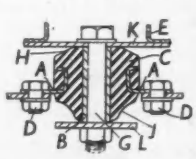
No. 732,219

The bracket *A* as shown incorporates two legs attached to the deck *R*. In operation, as the radius rod *B* swings about the pivot *C* and the radius rod *F* swings about the pivot *H* the davit arm *E* swings about the pivot *D*. The path followed by the upper end of the davit arm *E* as it moves outwards is substantially rectilinear and inclined downwards. In consequence, when the cable *P* is removed and the tension in the falls *J* is reduced the weight of the lifeboat and of the davit arm *E* causes it to rotate about the pivot *D*, and the radius rods *B* and *F* to rotate about the pivots *C* and *H* respectively, the action continuing until the davit is in the outboard position. When the pulley block *N* is clear of the upper end of the davit arm *E* the lifeboat is free to move downwards away from the davit arm. In the outboard position the load is borne by the pivot *C* connecting the radius rod *B* to the bracket *A*. The pivot is preferably of a length sufficient to provide adequate resistance to rocking of the davit in a fore and aft direction when the ship is pitching. The davit is operable for launching a lifeboat entirely by gravity and thus for launching purposes is independent of a supply of electric or other power. But a winch can be used where necessary.—*June* 22, 1955.

POWER TRANSMISSION

732,256. October 14, 1952.—BUSHES FOR RESILIENT MOUNTINGS, Metalastik, Ltd., Evington Valley Road, Leicester. (*Inventor : Alun John Reed.*)

The mounting, as shown in the drawing, consists of an outer metal element *A* and an inner metal element *B* with an intermediate bush of rubber or like material *C*. The outer element is in the form of a cylinder with radial flanges at both ends, one of the flanges extending outwards so as to enable the element to be secured by bolts *D* to the chassis or like supporting part. The inner metal element *B* is in the form of a cylinder of greater axial length than the outer element, and is designed to be secured to the engine or other supported part by the bolt *G* which passes through the element *B*. The rubber bush *C* has both its end surfaces, the upper or overload surface *H* and the lower or rebound surface *J* formed so as to be progressively engaged with its respective abutment surfaces either that of the plate *K* or of the washer *L* at the lower end of the bolt *G*. The outer element *A* is, except for its fixing extension, wholly embedded within the rubber bush *C*. The inner peripheral surface of the outer element and the outer peripheral surface of the inner element may be bonded to the rubber. Load deflection characteristics of the mounting are also included in the specification.—*June* 22, 1955.

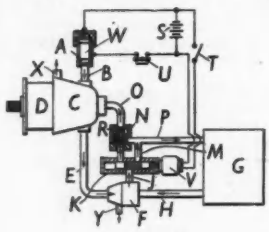


No. 732,256

GAS TURBINES

732,113. February 20, 1952.—STARTING UP TURBINE TYPE STARTERS FOR GAS TURBINES, The Plessey Company, Ltd., 56, Vicarage Lane, Ilford, Essex. (*Inventor : David Roy Trowbridge.*)

According to the invention, a system for starting up turbine type starters for gas turbines utilises the pressurised exhaust gases from a cartridge firing device, to supply the initial power for starting up the starter turbine, and for a fuel pump driven by a separate turbine supplying liquid fuel to the starter turbine combustion chamber. Referring to the drawing, it will be seen that a cartridge firing mechanism *A* is connected by a pipe *B* with the combustion chamber and turbine *C* fitted with a driven element *D*. The chamber is connected by the pipe *E* to the turbine-driven pump *F*. A tank *G* containing liquid fuel is connected to the pump by the pipe *H* and the outlet from the pump communicates through pipe *J* with an electrically operated piston valve *K*. The valve has two discharge outlets *M*. One branch pipe *L* leads to a flow control valve *N*, while the pipe *O* leads to the combustion chamber *C*. The other pipe from the valve *M* is connected to a by-pass *P* leading from the control valve back to the tank. The control valve *K* is spring loaded to enable it to move under the fuel pressure so that excess fuel can flow back through the by-pass to the tank *G*. As excess fuel is generally supplied by the pump, the loading of the control valve spring is chosen to allow the correct amount of fuel to pass through the orifice *R*. The electric circuit for operating the system consists of the battery supply *S*, the switch *T*, and the press button switch *U*. In operation the switch *T* is first



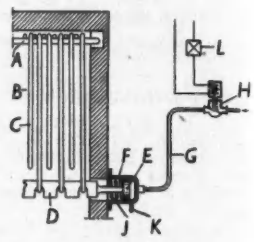
No. 732,113

closed to supply current to the solenoid *V*, when the piston valve *K* closes the pipe *M* and opens the other pipe. The press button switch *U* is next depressed to fire a cartridge *W* which causes pressurised hot gases to pass into the combustion chamber *C* for initially starting up the turbine-driven element *D*. Some of these gases pass through the combustion chamber to provide motive power for initially starting the fuel pump *F* which draws its supply from tank *G*, and forces it through the orifice *R* in the control valve *N*, through the pipe *O*, into the combustion chamber, where the spray is ignited by the hot gases. After the initial starting the pump continues to supply the combustion chamber and some of the gases from the chamber continue to drive the pump. The exhaust gases from the combustion chamber and the turbine *C* and the spent gases from the turbine-driven pump *F* are discharged through the respective exhaust pipes *X* and *Y*. To shut down the plant it is only necessary to open the switch *T*, when the solenoid valve *V* closes one pipe and opens the other pipe *M*, shutting off the supply of liquid fuel and allowing the fuel withdrawn from the tank to be by-passed back again to the tank during the final stages of the running down of the fuel pump.—*June* 22, 1955.

HEAT EXCHANGERS

732,104. April 18, 1951.—THE CLEANING OF HEAT EXCHANGER TUBES, The Aktiebolaget Svenska Maskinverken, Sodertalje, Sweden.

The drawing shows a device according to the invention consisting of a vibration-initiating apparatus operating electro-pneumatically. Movably suspended from the carrying pipe *A* in the gas passage *B* are the coils *C* traversed by a heat absorbing medium, the carrying pipe being also preferably cooled by a flowing medium. Every second coil is longer than the other and these extended coils may be laterally reciprocated by the action of the shaking bar *D*. This bar in turn is set into motion by the piston *E* in the cylinder *F*. The cylinder is supplied with compressed air through the tube *G*. Interposed in the



No. 732,104

conduit *G* is the magnet-actuated valve *H*, which serves to open or close the supply of air to the cylinder *F* according to a predetermined schedule. After a complete stroke of the piston *E* the valve *H* shuts off the air supply, whereupon the spring *J* forces the piston back to its initial position, the air behind the piston escaping through the small outlet *K* in the cylinder. The valve *H* is controlled by the electric relay *L*, which by means of a time gauge closes and shuts off the electric current to the magnet of the valve *H* to give the motion of the shaking bar *D*. Modified arrangements of coils and vibrators are also shown in the specification.—*June* 22, 1955.

Launches and Trial Trips

SOUTHERN SATELLITE, oil tanker ; built by the Furness Shipbuilding Co., Ltd., for Chr. Salvesen and Co.; length overall 556ft 5in, length between perpendiculars 525ft, breadth moulded 71ft, depth moulded 39ft 3in, deadweight 17,475 tons on 30ft 6¼in summer draught ; twenty-seven cargo oil tanks, two cargo pump rooms, four 500-tons per hour cargo oil pumps and four 75-tons per hour stripping pumps ; one steam-driven and two diesel-driven 95kW generators ; N.E.M.-Doxford single acting, two-stroke, oil engine, six cylinders 670mm diameter by 2320mm combined stroke, 6800 b.h.p. at 119 r.p.m., two Scotch boilers, trial speed 15 knots. Trial, June 20th and 21st.

ESCALANTE, cargo liner ; built at Govan by Harland and Wolff, Ltd., for the Royal Mail Lines, Ltd.; length between perpendiculars 415ft, breadth moulded 58ft 6in, depth moulded to shelter deck 38ft 4in, gross tonnage 7450 ; five cargo holds, twelve derricks, one 30-ton derrick, electrical deck machinery, three 135kW diesel driven generators, two vertical thimble tube boilers ; one Harland and Wolff two-stroke, single-acting, opposed piston, oil engine, six cylinders 620mm by 1870mm combined stroke, 115 r.p.m. Launch, July 5th.

LAGANBANK, cargo liner ; built at Belfast by Harland and Wolff, Ltd., for the Andrew Weir Shipping and Trading Co., Ltd.; length overall 455ft, length between perpendiculars 425ft, breadth moulded 59ft, depth moulded to shelter deck 38ft 3in, gross tonnage 5800 ; four main cargo holds, two deep tanks, one 25-ton, fourteen 5-ton, two 3-ton derricks, electric deck machinery; three 175kW diesel driven generators ; one Harland and Wolff opposed piston, single-acting, two-stroke, oil engine, six cylinders 620mm diameter by 1870mm combined stroke, 118 r.p.m., two vertical boilers. Launch, July 5th.

PORT MELBOURNE, shelter deck cargo liner ; built at Belfast by Harland and Wolff, Ltd., for the Port Line, Ltd.; length overall 533ft, length between perpendiculars 498ft, breadth moulded 70ft, depth moulded to upper deck 42ft. gross tonnage 10,470 ; twelve passengers ; six main cargo holds, some insulated; one 70-ton, four 15-ton, ten 10-ton derricks and two 2-ton and one 3-ton electric deck cranes ; electric deck machinery ; four 360kW diesel-driven generators ; two Harland and Wolff, two-cycle, single-acting, opposed piston oil engines, six cylinders 750mm diameter by 2000 combined stroke heavy grade fuel oil, 112 r.p.m. Trial, July 7th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

CHEMICAL SOCIETY

To-day, July 15th.—The University College of the South West of England, Prince of Wales Road, Exeter, Symposium on "Recent Work on Naturally Occurring Nitrogen Heterocyclic Compounds."

INSTITUTION OF CIVIL ENGINEERS

Thurs., July 28th.—MIDLANDS ASSOCIATION : Joint Meeting with the Institution of Municipal Engineers, East Midland District, at Nottingham.

SOCIETY OF CHEMICAL INDUSTRY

To-day and Sat., July 15th and 16th.—The University, Edgbaston, Birmingham, 15, Seventy-Fourth Annual Meeting.